

C. B. Martin, M. D.
with the Regard of
Henry F. Campbell.

Advance Sheets.

URINARY CALCULUS.

PART I.

THE SURGERY, THERAPEUTICS, AND HYGIENE OF URINARY CALCULUS.

Lithotomy in Children—In Adults—Study of the Nuclei of Calculus—Rate of Calculous Precipitation—"Constitutional Solvents"—Traumatic Calculi of American Civil War—Bilateral Lithotomy and Virility—The Influence of Drinking-water in the Production of Stone—The "Water History" of Calculi—Lithotomy and other Methods in the Female.

BILATERAL LITHOTOMY—THIRTY-NINE OPERATIONS IN THE MALE.

THE origin of calculous formations in the bladder is so various, and the conditions attending their development so numerous, that no surgeon, however limited his experience, can begin the task of making his personal record without recognizing the difficulty and yet obvious convenience of some method of classification. Lecturers and systematic writers vary their arrangement according to methods deemed most advantageous for imparting instruction. Our own object at present has little in common with these. It is simply to furnish the more or less carefully observed facts pertaining to a number of our cases of calculus and of lithotomy operations, the notes of which we have been able to recover, sometimes imperfectly, from among the rather scattered records of the past thirty years. A number of operations have been necessarily excluded on account of lost or entirely deficient notes. Classification is herein scarcely attempted. We do not presume to instruct, but simply to relate.¹

¹ As during the course of the present report we will have occasion to refer often to calculi of various constituents, we append the following classification, based upon the chemical constituents of the several varieties, from the Article "Urinary Calculi," in the last edition of *Cooper's Surgical Dictionary*, 1872.

In all the male cases herein reported the bilateral operation of Dupuytren was adopted. Having used this method in the first few cases, and becoming more familiar with it in each succeeding operation, for this reason, more than any other at first, it soon became our invariable procedure in all male cases, whether infantile or aged, emaciated or robust. From personal experience in any other method we cannot argue the superiority of this one, as in nearly fifty cases, we have not, in a single instance, used any other operation than Dupuytren's. Bilateral lithotomy, like every other method, as is well known, has not been an invariably successful operation. From one cause or another, unnecessary to mention here, many fatal results have occurred even in the hands of some of its most able and distinguished advocates. Mr. Coulson,¹ who strongly favors this operation, gives the following results: "Dupuytren lost nine male patients out of thirty-eight. Of the forty-seven operations performed by Sanson, Roux, Blandin, and Velpeau, ten were fatal. Finally, of twenty-three operations performed by Professor Eve of the Nashville University, four terminated fatally. We have thus a mortality of one in four and two-thirds, for the bilateral method." In regard to hemorrhage particularly, he says, "Dupuytren himself, Sanson, and others, have lost patients from bleeding. There is the risk, if the blades [of the double lithotome caché] be too widely separated, that they may come in contact with the rami of the ischia as the instrument is being withdrawn and so divide *both* pubic arteries. This accident, we believe, happened to Dupuytren himself. With a narrow pubic arch, it is not unlikely to occur."

The order and frequency of the several varieties have been carefully established by Dr. Prout, from the examination of 823 calculi. This is the classification most frequently referred to in the present paper.

1st. Uric acid calculi; viz., the uric acid, the urate of ammonia, and the uric oxide calculus.

2d. Those arising out of the oxalic acid diathesis; viz., the oxalate of lime or "the mulberry calculus."

3d. Those of the phosphatic diathesis; of three kinds, viz., triple phosphate of ammonia and magnesia, the phosphate of lime and the mixed or fusible calculus.

4th. The carbonate of lime calculus.

5th. Cystic oxide calculus.

6th. Fibrinous and other pseudo-calculous substances deposited in the bladder.

¹ "When the stone is known to be of ample size, the bilateral operation, I think, merits the preference to all ordinary plans." Article, "Lithotomy." Vol. II., 1872. *Cooper's Surgical Dictionary*.

In the experience of a considerable number of operations with the double lithotome caché we have had a number of quite young children, from two and a half to eight years of age, with of course very contracted pubic arches. We are confident, that on one or two occasions, the blades in being withdrawn were unavoidably sprung against the rami of the pubis,—yet in none of these cases did we have to contend with any serious hemorrhage. A very different and perhaps a fatal result might have attended such an occurrence in the case of the adult male. Fortunately, the very contracted pelvic arches are to be found mostly in children. In these, the organs of generation are yet undeveloped and their main artery—the internal pudic—even should one or both be cut, would not probably yield a very serious amount of hemorrhage. To this circumstance, we have no doubt, is due our immunity from hemorrhage. In the adult male we have had two very considerable primary hemorrhages and two really alarming, though not fatal, secondary bleedings; but we are confident they proceeded from the artery of the bulb (except in one to be hereafter mentioned) caused by cutting a little too much forward in making the longitudinal incision to pass in the beak of the lithotome, and not from any injury to one or both of the internal pudics. The *tampon en chemise* packed with pledgets of cotton-wool well saturated with a solution of Monsel's salt, always promptly and permanently arrested the bleeding, as will be seen in the description of our cases of hemorrhage.

The majority of the cases we are about to give presented so many points of similarity to each other, and to ordinary cases of vesical calculus, that no particular discussion of them could add to their interest. On the other hand, the few cases in this catalogue which are marked by peculiar characteristics were so diverse and aberrant, that no general remarks can be made to apply in common to scarcely any two of them. Such considerations, therefore, as may grow out of the peculiarities of such cases, we have most reluctantly determined to intersperse among the recountals of the cases themselves.

BILATERAL LITHOTOMY IN CHILDREN—TWENTY-ONE CASES.

CASE I. H. J., a white boy, aged about four years. Residence in De Kalb County, Georgia, near Stone Mountain (primitive granite); in the care of Dr. J. L. Hamilton. This child had

suffered from very early infancy, was much emaciated, but otherwise in favorable condition for the operation. Bilateral operation; very little hemorrhage; oblong stone, $1\frac{1}{4}$ inch in length; a good specimen of the oxalate of lime, very hard and somewhat nodulated; a chalky deposit on one end. Recovery speedy and complete.

CASE II. W. J., a white boy, eight years of age, a brother of the last patient, also living in De Kalb County, Georgia, under identical circumstances of air, food, and water, as Case I.¹ Bilateral operation, near Stone Mountain, assisted by Dr. Hamilton. Stone not analyzed, but entirely different in structure, color, and appearance from that of the brother; friable and chalky; weight seven drachms. This child had been in uninterrupted distress for many days, and had not slept for several nights. He fell asleep almost before the operation was completed. Dr. Hamilton reported that he slept nearly twenty-four hours. He recovered rapidly without any bad symptom.

CASE III. J. L., white child, under three years of age. Residence, Augusta, Georgia. Bilateral operation, July 23, 1855, assisted by Dr. Robert Campbell. Stone single, size of an almond; not analyzed nor weighed; probably triple phosphate. Recovery.

CASE IV. L. R., white child, aged three years. Residence, Hamburg, S. C., opposite Augusta, Ga.; healthy otherwise. Case kindly referred to me by Prof. L. D. Ford, of this city, who was present at the operation. Bilateral lithotomy, January 3, 1857, assisted by Drs. L. D. Ford and Robert Campbell. Stone white and friable; oblong; weight half an ounce; not analyzed. Recovery very rapid. "The child could not be kept in bed," and had stolen out of the room and was found playing in the yard on the fourth day after the operation; of course the wound had not healed. After the healing of the perineal wound, the power of retention was slightly impaired in this boy for a considerable time. He recovered, however, spontaneously.

Remarks.—Children, so to speak, "mind the operation" by the lithotome very little; most of our cases are difficult to control; they are disposed to play, to roll over and tumble about in the bed, just as soon as the smarting of the cut has ceased. The explanation we give for their good spirits is, that the relief by the removal of the stone causes them to forget the comparatively

¹ Stone Mountain, granite formation. No lime or magnesia in any water accessible to these patients.

trivial sore place in the perineum. We have never had a case of urinous infiltration to follow one of our operations, in either adult or child. We have never used a catheter or any other artificial "water way" in either the urethra or the wound, except where hemorrhage rendered packing with the tampon necessary.

CASE V. C. J., a white boy, aged two years. Residence, Augusta, Georgia. Bilateral lithotomy; a single brownish looking stone, round and slightly rough on the surface; not weighed nor tested; probably uric acid. Recovery.

CASE VI. Joe F., a colored boy, aged eight years, from Wilkes County, Ga. This case was referred to me for operation by Dr. J. B. Ficklen, of Washington, Ga., December 16, 1857. A small stone (about a drachm in weight) was lodged in the urethra, interrupting but not entirely preventing the passage of urine. This was removed by median incision. Pushing the sound on into the bladder, other calculi were found. The bilateral operation was at once performed, assisted by Dr. Ficklen and Dr. Robert Campbell. Two other calculi, both larger than that removed from the urethra, were removed. No test made; they were of reddish brown color, and their combined weight was about six drachms. Both wounds healed rapidly, and recovery was complete in the usual time. This boy had suffered with calculous symptoms for a considerable time; his bladder had been explored and the presence of stone detected by Dr. Ficklen, but he was brought to our hospital at that time on account of the recent lodgment of one of the stones in the neck of the bladder, the doctor fearing entire closure, as the stone resisted dislodgment back into the bladder.

CASE VII. William, a colored boy, aged twelve years, sent to our hospital by Dr. J. H. Pope, of Madison, Florida (limestone region). Bilateral lithotomy was performed in the ordinary way; stone not analyzed; weight somewhat over half an ounce. Recovery.

CASE VIII. Travis, a colored child, aged eight years. Residence, Madison, Morgan County, Ga.; "troubled in the bladder from infancy." Case referred to our hospital by our friend, Dr. G. B. Knight, of Madison, September 3, 1858. Bilateral operation; fawn-colored oblong stone, size of large pecan-nut; not weighed nor analyzed. Recovery rapid and complete.

CASE IX. Minor, a colored boy, aged ten years. Residence, Lexington, Oglethorpe County, Ga. Bilateral operation; a

light chalky looking stone; weight half an ounce and 21 grains; not analyzed. Recovery.

CASE X. Daniel Evans, a colored boy, aged six years. Sent to hospital from Brothersville, Richmond County, Ga., Nov. 15. Bilateral lithotomy Nov. 17, 1859. Discharged well Dec. 22, 1859. Stone light colored; weight about half an ounce; not analyzed.

CASE XI. Ben Fitz Patrick, a negro boy, aged about seventeen years. Residence, Warrenton, Warren County, Ga. He had "suffered from early childhood with his water." Bilateral operation performed at Jackson Street Hospital June 3, 1858. Profuse and exhausting hemorrhage, with great nausea, four hours after the operation. The hemorrhage resisted applications of ice, and we were preparing to apply the tampon, when it ceased suddenly and spontaneously on his vomiting a large mass of orange pulp which he had eaten clandestinely. There was no return of hemorrhage, and he made a good recovery; weight of stone nearly one ounce, white and friable; not tested.

CASE XII. John, a colored boy, aged six years. Residence, Richmond County, Georgia. Bilateral operation; two small white stones, weight estimated three drachms; not tested. Recovery.

CASE XIII. J. D., white boy, aged seven years. Residence, Augusta, Ga. Had suffered from vesical irritation from early infancy. Operation bilateral; single stone of fawn color, size of lima bean; not tested. Recovery in usual time.

CASE XIV. I. J., white boy, aged thirteen years. Residence near Marietta, Cobb County. Bilateral lithotomy; stone weighed half an ounce, of dark brownish color, probably uric acid. Recovery.

CASE XV. C. J., a white boy, aged about ten years. Residence, Augusta, Georgia. This case was in the hands of our esteemed friend, the late Dr. W. E. Dearing, who performed the operation, we consulting and assisting. Bilateral lithotomy; stone oblong, and of a chalky appearance; not tested; weight about six drachms. Recovery.¹

CASE XVI. D. S., white child, aged eleven years. Residence, Barnwell, S. C. This child had suffered from urinary difficulties for a long time; was pale and emaciated. Bilateral operation;

¹ This case is here reported, giving full credit, as we believe no presentation of it elsewhere has been made.

stone a white oval mass, one and a half by three-quarters of an inch; not weighed nor tested; probably phosphate of lime. Recovery.

CASE XVII. P. McC., a white boy, aged eight years. Residence, Augusta, Georgia. Bilateral operation; a small brownish stone, uric acid. Recovery.

IN CASES XVIII. XIX. XX., the records are imperfect. We find them briefly noted among "white male children" on whom we have operated. They were all bilateral operations, and all recoveries. We have never employed any other method, and have had no death among children.

CASE XXI. Luke C. Willis, aged three years, from Wilkes County, Georgia. The child had given evidence of vesical irritation when about eleven months old. These symptoms had continued and increased to the present time. Patient pale, and somewhat emaciated; otherwise healthy and sprightly, when not in pain from the stone. August 3, 1878, bilateral lithotomy was performed in the ordinary way. Small uric acid calculus, 38 grains troy, was removed. Patient returned home in a week. Recovery complete, with no return of symptoms.

While in the opening paragraph of this report it was distinctly stated that no systematic method of classification would be attempted, it will be observed that all cases in which stone could be distinctly shown to have originated in infancy or in very early childhood, have been rather carefully grouped together. We fully believe, with several other writers on this subject, that a large proportion of those operated on in adult life have been the subjects of vesical calculus from early infancy, and that they should, in relation to the origin of the disease, be classed with infant cases. This early date of many of such cases is rendered more probable by the fact that, in a great many instances the size and weight of the stone seems to have an obvious reference to the time occupied in its formation, being somewhat commensurate with the age of the patient operated on. We have not had time, however, to consider each one of these cases in such a relation, and have grouped with children only those adult cases which we could clearly and distinctly make out as having been afflicted with calculous distress from the earliest periods of life. In the above grouping of our infant cases, and in the subsequent allocation of the adults, we wish here thus early to announce

the important object we have in view. It is that we may, by a careful study of them, in philosophic relation with various other facts and considerations, heretofore perhaps not often associated in such researches, if possible, arrive at some truthful and rational result, as to the origin, causes, and influence pertaining to the process of lithogenesis. Whether we have adopted the most advantageous method for utilizing these cases to this important end, we will not be able to decide till after the rather unusual and complex investigation has been completed. Some of the cases hereafter to be presented exhibit complications and peculiarities which give them much variety of interest. We shall endeavor, notwithstanding such irrelevant points of interest, to follow out persistently the main object of the present communication—the *Etiology, Rationale, and Progress of Lithogenesis*.

LITHOTOMY IN ADULTS—TWENTY CASES OF CALCULUS IN THE MALE.

Among the following adult cases, the notes of several will be found that have not been the subject of operation at all. They were cases, however, the course and progress of which we think will be regarded as well worthy of note, inasmuch as they present certain particular facts possessing a significant bearing upon the nature and treatment of calculous affections. Any peculiarities of the following cases deemed worthy of remark, will be discussed in connection with the notes, without perhaps any reference being made to them again.

CASE XXII. J. B. A., young man, white, aged twenty-one years, a resident of Floyd County, Georgia, had suffered from symptoms indicative of stone from childhood. Stone in bladder detected by Prof. H. V. M. Miller, who requested that we should operate. Bilateral operation performed at Rome, Georgia, April, 1852, assisted by Dr. Miller and Drs. R. C. and T. J. Word. Two uric acid calculi, of dark brown color, thickly studded with mulberry nodules; combined weight nearly one ounce. Case left in charge of Dr. Miller. Recovery complete, without any untoward symptoms.

CASE XXIII. Monroe, a mulatto man, aged about twenty-two years, was sent to Jackson Street Hospital from Madison, Morgan County, Georgia. Patient was well grown, healthy, and muscular. Bilateral lithotomy, assisted by Dr. Robert Campbell, Aug. 16, 1857; stone large and round, of a dark brown color,

probably uric acid; not tested; weight two ounces and forty-eight grains. Recovery rapid and complete. Virility, in this case, was seemingly unimpaired, as it was notorious among the nurses and patients then at the hospital that a woman in the yard had become pregnant by Monroe, previous to his discharge from the institution, and after the operation.

CASE XXIV. A young white man, aged about nineteen years. Residence, near Conyers, Rockdale County, Georgia. He was referred to the College clinic of operative surgery for treatment. Bilateral lithotomy was performed in the presence of the class, in which we were assisted by Drs. Geddings, Coleman, and Robert Eve. The stone was of a dark brown color, probably uric acid, of rather large size, and weighed one ounce and six drachms. No unusual incident attended either the operation or his rather easy recovery while in the city hospital, where he remained for two weeks previous to his return home.

CASE XXV. W. B. S., a white boy, aged eighteen years. Residence, Barnwell, S. C. He was emaciated and delicate, with a distressed expression of countenance; had suffered extremely from vesical trouble for some years. He said he was often "unable to pass water except in drops." The stone would often get into the neck of the bladder, and though it did not cause complete retention, would distress him for days. Careful examination detected a small rough stone near the *bas fond* of the bladder. Bilateral lithotomy was performed May 4, 1869. The calculus was very small, of a flattened cuboid shape, and of a whitish color, but extremely hard. It weighed over two drachms; horizontal dimensions, one-half inch by three-quarters of an inch; perpendicular, five eighths of an inch. The two broader surfaces were studded with hard and short mammillated projections, which rendered this stone, the one most calculated to grind and irritate the bladder of all the specimens, large and small, we have ever seen. It has not been analyzed; we have regarded it as composed of oxalate of lime. In contour and roughness of surface it is an exaggerated specimen of the mulberry variety. There was nothing worthy of remark connected with the operation. The patient progressed prosperously until the tenth day, May 14th. At this time, a secondary hemorrhage of the most alarming character took place, the blood passing both from the wound and from the urethra. Our friends, Drs. Edward Geddings and J. S. Coleman, both of this city, who had, with others, assisted me

in the operation, kindly visited the patient in my absence. All ordinary efforts, as applications of ice, etc., failed to arrest the bleeding. They very promptly proceeded to tear open the nearly closed perineal wound, and applied the *tampon en chemise*, after which only clear urine flowed through the tube. We allowed the tampon to remain about forty-eight hours. When it was removed, there were some evidences of suppuration, but we had no return of hemorrhage. The wound rapidly contracted and healed again. Notwithstanding the accident of hemorrhage, the patient made a rapid and complete recovery in the usual time. It is our opinion that the bleeding came from the artery of the bulb—and that this vessel was nicked at the time the longitudinal incision was made for the introduction of the beak of the lithotome. We are very sure that the blades were not set wide enough to wound either of the internal pudics.¹

CASE XXVI. John, a colored boy, aged seventeen years, sent to Jackson Street Hospital, Oct. 15th, 1853, by Messrs. D. and S., merchants of this city. Residence not noted. Bilateral lithotomy; oblong stone, weight about six drachms, white and chalky, triple phosphate probably. Recovery.

Of the following cases the records we have been able to recover are too imperfect to admit of their being applied to any purposes of induction, except as so many adult male cases in which bilateral lithotomy had been performed and had resulted successfully. We report them as white cases, since we have a full record of all our colored cases, amounting in all only to ten. The exact ages, residence of patients, time of operating, are points, the records of which have been lost. They were all operations previous to 1860. Having the specimens, we have weighed them. Time does not allow us to make of them any reliable test. In the table furnished Dr. Mastin for his report, these cases, we think, are set down as resident in Georgia.

CASE XXVII. White adult. Bilateral lithotomy; calculus white externally, flaked off apparently during operation by forceps, leaving a broad surface of reddish-brown and rough material; this layer is almost certainly uric acid; weight of stone 380 grains troy. Recovery.

CASE XXVIII. White adult. Bilateral lithotomy; calculus

¹ See note of Prof. F. L. Parker relating to retained virility in this case—Case XXXIX.

probably uric acid, but with white chalky deposits on a portion of its surface, not bisected but probably of alternating layers, somewhat oval in shape; weight one ounce and ninety grains troy. Recovery.

CASE XXIX. White adult. Bilateral lithotomy; calculi extracted—five irregularly-shaped white cuboid stones, the largest weighing 120 grains troy, the others much smaller—combined weight, 260 grains troy. The composition of these specimens is, we believe, of the triple phosphate variety, as they exactly resemble in color, shape, and texture, the large number from our other multiple case, O'Bannon, reported by Dr. Paul F. Eve, of Nashville, and also found (see Case XXXIX) in this list. Recovery.

CASE XXX. Adult white male. Bilateral lithotomy; stone oblong, white, chalky, weight 180 grains troy. Recovery.

CASE XXXI. Adult white male. Bilateral lithotomy; stone white, chalky; uric acid nucleus; broken part lost. Recovery.

CASE XXXII. J. B., white man, aged seventy-three years, a resident of Edgefield County, S. C. Our attendance was requested by Dr. Hugh A. Shaw, of Edgefield. We found Mr. B. extremely emaciated. He was worn down by irritative fever, and prolonged vesical distress, and loss of sleep. His appetite was gone, he ate almost nothing. All his symptoms seemed, at the time of this visit, to indicate that he would not survive the operation if then attempted. After consultation, we refused to operate, plainly stating to the patient our apprehension as to the result. He was advised to take bicarbonate of soda and other antacids freely. Quinine in both tonic and anti-periodic doses with iron was also given, but we did not encourage him to hope anything from an operation. We left him at that time, indeed, never expecting to see or hear of him again alive.

Two weeks subsequent to the above visit, to our great surprise, we received another note from Dr. Shaw, in which we were informed that "Mr. Bledzoe was still alive, that he thought himself much better, that he insisted on the operation being performed, as he could not sleep, and suffered interminable distress."

On this second visit, though finding the patient, so far as we could see, in no way any better, we somewhat regretted our refusal to operate, simply because he had shown more endurance

than had been suspected. We found it now impossible to resist his appeal, urgent and not altogether unmixed with accusations and reproaches. He urged that the operation would give him rest, and that in case he died, he would not, at his age, be deprived of many years. Though not fully assenting to the legitimacy of all his arguments, we determined that to operate was not altogether an unwarrantable procedure. Assisted by our friend Dr. J. S. Coleman and Dr. Shaw, we performed without difficulty the bilateral operation, the patient being under the influence of the anæsthetic mixture. Several dark stones the size of small marbles were removed; there were also removed some jagged angular pieces, probably fragments of another stone which had broken in the bladder. We think they were of uric acid. The operation was followed by decided relief; he slept well and his condition for some days allowed hopes of his recovery. His appetite and strength, however, did not improve. The vesical tenesmus again began to distress him; low fever set in, and he died on the ninth day after the operation. Whether his death was hastened or retarded by the operation we have not been able to decide.

CASE XXXIII. B. D., adult white man, aged about thirty-five years. Residence, Madison, Morgan County, Georgia. Had been the subject of calculus for many years. This case was kindly referred to us by Drs. A. A. Bell and A. C. Perry, of Madison, who had discovered the existence of stone, and wrote urgently requesting that we "should visit the patient prepared to perform lithotomy, which his condition seemed urgently to demand." This patient was of irregular habits, and subject to occasional prolonged attacks of *mania-à-potû*, from which he had previously recovered after protracted exhaustion. His present extreme condition was attendant upon one of these attacks. He was almost unconscious—in a state of muttering delirium. Sleep interrupted by constant vesical distress. The urine was scanty and purulent. After consultation with his two attending physicians, and with Dr. G. B. Knight and other gentlemen of Madison invited to conference in the case, we hesitatingly decided in favor of the operation as the only measure offering him the least chance of recovery. Assisted by these gentlemen, bilateral lithotomy was performed. Anæsthetics were not administered, as the condition of the patient seemed to render them hazardous, and also from the fact that in his semi-conscious state he was apparently insensible to the incisions as well as to the

introduction of the sounds and grooved staff. The stone is quite a large one, the size of a duck egg, of a dark reddish color; not tested, but probably of the uric acid composition. It weighed two ounces two drachms and twenty-one grains troy. There was considerable hemorrhage at first, but it was promptly arrested by the *tampon en chemise* before any exhaustion was manifested by the pulse. Leaving Madison a few hours after the operation, a letter from Dr. Perry informed me that Mr. D. did not recover from the low delirium in which the operation was performed; that there had been no return of hemorrhage, and that he died on the sixth day after the operation.

These last two cases are the only ones out of what we believe to have been a series of over fifty bilateral operations (for there are many specimens in our collection we have not pretended here to place on the list for want of notes) that have terminated fatally. We have seldom or never refused to operate, therefore this is not a report of selected cases. This last case (and indeed that preceding it) did not appear any less suitable for operation than several others that finally recovered.

THE NUCLEI OF CALCULOUS FORMATIONS.

Having in our collection a number of specimens which have been precipitated upon *nuclei* of rather unusual character, we here make their record the occasion to offer a few remarks upon this very essential element of every stone. Whatever may be the particular influences which underlie, and give rise to, any calculous deposit, the existence of a *nucleus* is the earliest event in the history of the accretion. Whatever may be the chemical constitution of the urine, or the particular *diathesis*; whether it be loaded with urates or phosphates, or with the oxalate of lime, it is, we think, very generally admitted, that until some more or less solid centre for accumulation is presented either from within or from without, the subject will continue to escape the calamity of stone. Finding no convenient *terms* by which to designate the two entirely distinct classes of vesical and renal *nuclei*, we ask for the exercise of some patience and deprecate severe criticism in humbly venturing to introduce the following descriptive names into the nomenclature of our subject:—

First. *Iliogenic*¹ *Nuclei*.—Those stone-centres which originate spontaneously within the body.

¹ From *ἰδιος*, proper to one's self, and *γενεσις*, origin.

Second. *Xenogenic*¹ *Nuclei*.—Those stone-centres which are of foreign or extraneous origin and introduced into the urinary passages.

IDIOGENIC NUCLEI.

By far the largest majority of calculi are of course found to be deposited upon *idiogenic* nuclei, for it is due only to accident or to some very unusual circumstance, that foreign bodies ever find introduction into the urinary cavities or passages.

To attempt a discussion of the origin and mode of production of our first class of calculous nuclei, would be but to repeat some of the most intricate, and not always most satisfactory, investigations of modern urology; such as would not at all comport with either the object or the restricted scope of the present paper. Much that is fairly reliable, however, has been with increasing certainty arrived at; and in the excellent works of Prout,² Golding Bird,³ Harley,⁴ Black,⁵ and Roberts, it will be found that more or less particular attention has been given to the initial crystallization of the special elements of the urine, that may or may not become the beginning of a renal or vesical calculus; everything depending upon the locality of its detention or whether it be retained within the body at all. Of the common products of the urine, uric or oxalic acid or cystin are those most frequently found to constitute the idiogenic centres around which the phosphates of lime, magnesia, or ammonia are deposited. While any one of these materials, especially, it is said, the cystin, may of itself constitute the entire stone or may be found to alternate in regular succession with any of the phosphates, or possibly, though more rarely, with each other.

“In connection with the origin of calculi,” writes Dr. Harley, “there is another point deserving of particular attention, namely, that local causes are the most potent in the production of stone, and that, even where the predisposition to it exists, without some local cause no stone is likely to form.” This remark is doubtless in every respect true, for all observations and experience teach that, whatever may be the condition of the subject's health, and however normal may be the urine in its constitu-

¹ From ξένος, foreign or strange, and γένεσις, origin.

² Stomach and Renal Diseases. Philadelphia, 1843.

³ Urinary Deposits, 1859.

⁴ The Urine and its Derangements. By George Harley, M.D., F.R.S., 1872.

⁵ Functional Diseases of the Renal, Urinary, and Reproductive Organs, 1872.

ents, from the moment any object is presented that may serve as a nucleus, the deposition progresses with more or less rapidity. On the other hand, it is equally well established, that daily precipitations of uric acid or of the phosphates may go on for years, and yet, there being no nucleus present, a stone is never formed. The question as to what determines the initial crystallization—whether in the kidney or in the bladder—which is to form the nucleus, and again, as to what accelerates the precipitation which is to form its homogeneous or its alternating crust, are mysteries which we fear are at present beyond our grasp. The chief interest of the inquiry into the significance of a certain number of our cases resides in a question distinct and separate from these, and one which may be formulated thus: *What are the influences which underlie the various calculous diatheses, and what are the instrumentalities by which the urinary cavities and passages are rendered liable to the deposition of calculous concretions within them?* This question is here stated, as it pertains more particularly to the consideration of our first class of nuclei. Its discussion will be deferred until after the presentation of a number of cases, some one or two of which we think have a particular bearing upon its solution.

There is another variety of idiogenic nuclei, the mention of which, at least, we think it is here necessary to record; first, because by many authors they are confidently referred to as being frequently, some say invariably, concerned in the rationale of the formation of stone-centres; and secondly, because more than one of our own cases most unquestionably indicate, that the calculi had been formed upon nuclei belonging to the class to which we are about to refer. These which, for convenience, we must necessarily class among the idiogenic nuclei, may be represented by agglomerations of vesical mucus, and by hardened blood-clots remaining in the bladder and serving as centres of deposit for the precipitable oxalates or urates, or for the phosphates of lime or of ammonia and magnesia. Vesical mucus, we have little doubt, is in young children most frequently the cement of the primitive nucleus upon which the deposits are made, though of this, we distinctly state, our opinion is based more upon the observation of the frequency of vesical irritation in this class of patients than upon any chemical analysis or experimental research. As will be seen hereafter, a uric acid calculus of considerable dimensions was unquestionably formed, in one

of our female cases, upon an inspissated blood-clot remaining in the bladder.¹

XENOGENIC NUCLEI.

There is but little that it is necessary to say concerning the specific characters of extraneous bodies which happen to become the centres of vesical calculi; they seldom or never originate renal concretions. To enumerate them would but involve the task of searching through the records of lithotomy, and then making a catalogue of sometimes rare, curious, and astonishing objects which have, at one time or another, been found to constitute the nuclei of stone. Among them, pins, needles, slate-pencils, a bit of bee's-wax, barleycorns, beans, hair-pins, bougies, catheters, a fœtal tibia, pieces of wood, besides many other unheard-of and curious substances which accident or hallucination has, at various times, caused to be introduced into the bladder—would all find their places in the surprising lists recorded by various surgeons. We could greatly extend this marvellous exposition, but the contour and character of the substance have seldom much to do with the process of stone-deposit. It is only a solid body, whatever its nature may be, that is required to supply the conditions necessary for the accumulation. "Any solid substance, indeed," says Dr. Harley, "may prove the starting-point of a vesical stone, just as a thread, a piece of string, or anything else, may form the nucleus of a crystal of sugar candy."²

One of the questions of chief importance relating to xenogenic nuclei, is that which bears upon their *modus operandi* in initiat-

¹ "As regards the first step in the formation of vesical calculi," says Dr. Harley, "it may with equal justice be said that, whenever the predisposition to stone exists, it requires but a very trivial cause to bring it into operation; for, as with renal calculi, almost anything may act the part of a nucleus round which the stone will become deposited. An insignificant particle of mucus, a microscopic portion of albumen, or an epithelial cell is all that is requisite for the purpose. In the vast majority of vesical calculi, indeed, it is impossible to detect the primary point round which the urinary salts become adherent; but every now and then we come upon calculi with well-marked nuclei, some of which are not only quite foreign to the urinary passages, but even foreign to the body itself."—*Op. cit.*, pp. 134-5.

² For a numerous collection of singular nuclei, we refer the reader to Dr. Gross "On the Urinary Organs," to Eve's "Remarkable Cases in Surgery," and to other systematic works on lithology and surgery. Dr. John Godfrey, of U. S. Marine Hospital, Mobile, Ala., reports that a filiform bougie retained in the bladder, had thirteen small calculi upon it, like beads, when removed by lithotomy.—*N. O. Med. and Surg. Journal*.

ing and in accelerating calculous precipitation. *Is their action in this precipitation only that of "the thread" or of "the piece of string in sugar candy," or—vital elements being considered—do not both idiogenic and foreign nuclei exert a far different and more positive influence than the quasi catalysis of their mere presence?*

This problem which seemed to us unavoidable, is again one, of which we hope to attempt the solution, in connection with some of the examples of both idiogenic and extraneous nuclei hereafter to be presented.¹

A Vertebred Catheter Broken. The joints and connecting wire-chain being left in the bladder as nuclei for calculous precipitation. Bilateral lithotomy. Recovery.

CASE XXXIV. George S. Almond, of Elbert County, Georgia, aged twenty-six years, in March, 1878, after certain "head-symptoms" found himself, without having had stricture previously, the subject of severe spasmodic trouble in his bladder. On 15th and 16th March he had obstinate retention of urine. On 17th a vertebred catheter was used by his physician. On its first application the instrument was broken, and the entire number of joints with the wire-chain were left in the bladder of the patient. The distress, of course, was greatly increased, and the retention of urine continuing, an ordinary silver catheter was used successfully to empty the bladder. Two or three days after, three of the joints were removed from the urethra by his physician. Six weeks after some four or five more came away spontaneously, and also a piece of the wire which had been used by the village watchmaker in repairing the instrument which had been broken previously to its application in his case.

From the time of the accident to that of the operation, July 30, 1878, he suffered continued distress and tenesmus, "passing very small quantities of urine every fifteen or twenty minutes, night and day, and having scarcely any rest." He was much emaciated and worn down with irritation and some fever; had frequent chills and febrile exacerbations. On this account, notwithstanding the intense heat, Dr. M. P. Deadwyler, into whose hands the case had fallen, insisted on an immediate operation.

¹ We here gladly make our acknowledgment to Prof. W. W. Dawson, of Cincinnati, whose beautifully prepared and polished specimens we preferred to our own, on account of the distinctness of the strata; better illustrating our views on nuclei, during the reading of this paper.

The foreign body being plainly cognizant to the sound, bilateral lithotomy was performed at the City Hospital, in which we were assisted by Drs. John S. Coleman, A. Sibley Campbell, E. C. Goodrich, E. Foster, and others. The lithotome was set for a small incision in perineum and bladder, as we thought a large one could not be necessary. The object, or objects, were readily seized and removed by the forceps. They consisted of four of the joints of the catheter, and seven links of the wire chain, from which the other eight hollow joints had slipped off and passed out of the bladder as previously stated. Two of the joints were deeply incrustated with calculous matter, and also five of the links of chain, the cavities of all the joints were also filled. It had evidently been rubbed off from two of the joints by attrition in the bladder. The drinking water of this patient showed no evidence of lime by the ammonium oxalate test.

The patient did well after the operation, the urine dribbling away at intervals from the wound and sometimes passing from the urethra. The wound was almost healed by the end of a week. On the seventh day from the operation secondary hemorrhage suddenly took place. The bladder became filled with large clots which greatly distended it and caused intense suffering. The hemorrhage was probably caused by the patient's getting up to the close-stool, most imprudently, to pass his water. The urine was passed through the wound, but from the first so small had been the incision, involving the sphincter so little, that he had control and passed it only "when called on." The hemorrhage was finally arrested by the *tampon en chemise*, which was kept in for one night. The urine after removal was again passed as before under control. He took quinine daily, and left the hospital well on the seventeenth day after the operation.

Remarks. It will be seen by our next case (XXXV.) the breaking of a bougie is not an unprecedented occurrence, and in the course of this report one or more catheters have been found to constitute the nucleus of calculi giving rise to lithotomy. The vertebrated catheter being somewhat a recent invention, it would scarcely have been expected to furnish, as yet, many nuclei for calculous precipitation, and yet our own case, as just reported, is not without a precedent in the brief history of this dubiously useful contrivance. An amusing account was published recently in one of our medical journals in which the patient who had been in the habit of using a vertebrated catheter for evacuation

of his bladder, sent to his physician "to send him another, as his old one had been broken off and lost in his bladder, and he could not get along without *something* to empty his bladder." Ignorance truly is bliss!

In the *Union Medicale* of June 11, 1878, M. Lannelougue communicated to the Société de Chirurgie a case on the part of M. Fleury, of Clermont. The subject was a gentleman, 78 years of age, of robust constitution and remarkable energy. In 1863 M. Civiale performed lithotomy on him, and he had been obliged ever since to use a catheter, a slight vesical catarrh remaining. The instrument was five millimetres in diameter, and had become roughened from long usage. He introduced it easily as usual on April 23d, and on withdrawing it he found a portion remained in the canal; in place of sending for his physician to extract it, he forced it into the bladder with another instrument. M. Fleury, when consulted, advised "expectation," as he considered the attempt to remove a metallic body of those dimensions would be very doubtful of success, and cystotomy at his advanced age would be hazardous. There was but a moderate degree of inflammation caused by its presence. Catheterism was performed without difficulty. *Four days after*, during an effort at stool, *the end of the catheter presented itself at the anus*, and was removed after a few tractions. From this time the pain diminished, and no urine passed out of the rectum. The patient resumed his former habits of life, and the bladder held the urine for five or six hours as heretofore. It is most probable, we think, that this fragment did not pass out by ulceration, as seems to be supposed, but that it was pushed through the recto-vesical septum at the time that the patient forced it into the bladder with the other instrument.

The following cases have relationship and bearings upon other considerations, besides the one which has been throughout this entire communication our chief object of interest and pursuit, viz.: *To arrive at a demonstration, or haply only a theory, of the cause of litho-genesis and of the calculous diathesis.*

Demonstration or theory, we are of course by no means indifferent as to which it shall be regarded; but our desire is to give what coherence we may be able, to many scattered and disjointed facts, long in possession of the profession, which bear directly upon our subject and which, by proper consociation, we humbly hope may offer an explanation where as yet, to our knowledge, none has been systematically attempted.

Cases of Vesical Calculus with Xenogenic or Foreign Nuclei. The rate of calculous precipitation. The solubility of calculi.

The following case of calculus with extraneous nucleus would appear to indicate the solvency of stone under the influence of change in drinking water, besides approximately illustrating the rate of calculous deposition.

CASE XXXV. J. T. O'D., a young gentleman aged about twenty-five years. He was originally a resident of New York, where, while under treatment by a surgeon some two or three years previously for stricture, he sustained the accident of *the breaking of a wax bougie in the bladder*. Efforts were made at the time to remove the foreign body, but he had suffered from vesical irritation up to the time of our examination in Augusta, in 1860, at which time we found in the bladder a stone of considerable dimensions. Leaving New York shortly after the accident with the bougie, he had lived a rather sedentary life in Florida, where he suffered only occasional inconvenience. Lithotomy was strongly urged upon this patient at the time of our examination. He however refused, and being separated from him he did not come again under our care until 1863, when he was detailed as a clerk in one of the military hospitals at Richmond, Virginia, of which I had charge. He had been pronounced unfit for active service on account of the urinary difficulty. During his residence in Richmond, he had a varying amount of discomfort with his calculus. After some months he began to have frequent attacks of vesical irritation, urine became turbid and then sandy; power of retention impaired. "On one occasion," as he described the occurrence, "as he was descending an irregular path down Church Hill, he felt the stone change its position; he had an urgent desire to urinate but without being able to pass any water. Violent and uncontrollable straining followed, in the midst of which *he distinctly felt something crush in the bladder*." He soon passed some urine with great pain, and it was highly colored with blood. Some small fragments of stone passed out with the urine. One of these of considerable size lodged in the urethra and was removed by instruments next day. After this he was constantly distressed by urethral obstructions. Dilatation was begun, but the rapid decline of the patient rendered this too slow a process. He was soon confined to bed, had irritative fever, with offensive and purulent urine. Ascertaining by the sound that there were

considerable masses in the bladder too large to pass the urethra, and too numerous for the precarious and irritating process of lithotritry in his extreme condition, we urged the operation of lithotomy as an immediate and imperative necessity. The bilateral operation was performed in the presence of the staff of the hospital and several medical gentlemen of Richmond. About an ounce and a half of broken uric acid stone was removed. Though very friable, there were many large lumps, showing how forlorn would have been the hope of spontaneous expulsion. No wax or other material of the bougie could be discovered, but along the centre of one or two of the large pieces, a distinct groove indicated plainly that the stone had been moulded upon a cylindrical staff of about No. 10 size. The wax had doubtless been dissolved or disintegrated in the many years that had elapsed since the deposit had begun. In this operation Dupuytren's instrument had been carefully set for a moderate cut, as the patient was rather of short stature. It must have been meddlesomely handled. The freedom of the backward cut greatly surprised us, and there was considerable hemorrhage at the time, which soon ceased. In some three or four hours after, the most alarming bleeding took place; so profuse that it must be acknowledged that it was to be feared at the time, one or both of the internal pudics had been cut. Having no *tampon en chemise* I improvised one from the vaginal tube of Mattson's syringe, by which means the hemorrhage was promptly arrested and did not return. The patient rapidly regained his flesh, and, hearing from him some five or six years after, he had enjoyed uninterrupted good health.

The Solubility of Calculi.—To the above rather prolonged description we feel compelled to add certain observations based upon notes taken at the time the above case was under our care. We think there are some interesting and unusual considerations attaching to the origin, structure, gradual disintegration, and final crushing of the stone, which may have, perhaps, a practical bearing. During the progress of the calculous deposition upon the wax bougie, our patient had changed his residence and consequently his drinking-water *four times*. He had lived over a year in New York City after the accident, drinking most probably the soft Croton water; then, about three years in Florida, where the water is hard with calcareous elements; after this he remained more than one year and a half in Augusta, Georgia,

using drinking-water entirely soft from the Sand Hill Turknott Springs, by which the city was then principally supplied. At this time the stone was detected and found, though large, to be as yet single and unbroken and rather oblong, so far as could be estimated by combined examination through the rectum and urethra. He then removed to Richmond in the latter part of 1862. He had resided there perhaps about six months, when evidences of solution and disintegration began to be shown. These ended in the final "crushing" as above described.

It is well known to those familiar with the geological characteristics of Virginia, that among its rich variety and abundance of mineral waters, analysis has developed, in several sections of the State, that *sulphate of alumina and potassa* in various combinations very largely predominates. Rockbridge County, located over one hundred miles nearly due west from Richmond, is, by general notoriety, most abundantly supplied with these aluminous ingredients, though the catchments furnishing the percolation must be very extensive, for in Henrico County, where Richmond is situated, at least in the vicinity of this city, the impregnation renders the water from some springs almost undrinkable. This we found to be the case with certain wells or springs from which some of our hospitals were supplied during the war. This area extended over a portion of Henrico County lying upon the James River, and comprehending Church Hill, Chimborazo Heights, and other elevations selected for military Hospitals. We cannot say how general was the aluminous impregnation of the water, but in the particular hospital, the First Georgia, in which our patient resided, the solution was strong enough to render the water disagreeable to persons unaccustomed to its use. To what extent this last change of water may have influenced the sudden, rapid, and almost fatal disintegration and crushing of the stone, or whether it may have been the alum or some other ingredient in the water, could only have been determined at the time by elaborate experimental processes perhaps, the conduct of which were obviously incompatible with the engrossing demands upon the time and attention of a military surgeon in charge of hospitals, surrounded by daily battle and in the very centre of active war. The tubular or spool-like form of the stone, it will be remembered, presented an internal as well as an exterior surface for the application and chemical action of alkalinized urine upon the uric acid concre-

tion of which the stone undoubtedly consisted. We do not know that urine would be alkalized by the habitual drinking, for six months, of this or even a stronger solution of the same ingredients. Such, however, are the main facts relating to our case, the rather inaccurate account of which, as to the dates of its early history, we greatly regret.

The two following cases though not belonging to the catalogue of lithotomy we introduce in connection with Case XXXV. as illustrative of the influence of "constitutional solvents."

CASE XXXVI. R. Y., a young white man, aged about eighteen years, resident of Augusta, came under our care in 1845. He was the subject of much vesical irritation supervening on gonorrhœa or upon the abuse of diuretics as we supposed; vesical tenesmus constant. This was easily quieted by very moderate doses of morphine— $\frac{1}{8}$ gr.—three or four times a day. The form of administration had reference to the acid urine, which was found to be present. Bicarbonate of soda was a prominent ingredient in his prescription. A brick-red deposit would reappear in the vessel after standing when the soda was omitted.

R. Chloric ether	f℥j.
Sodæ bicarb.	℥ss.
Morph. sulphat.	grs. ij.
Aquæ camph.	f℥vij.

Mix and write: Take one tablespoonful two or three hours apart, p. r. n., to relieve irritation.

Though the above preparation afforded much relief, a continuance of irritation induced us to insist on sounding for stone. This was done in the presence of and assisted by our friend Prof. L. D. Ford, of this city, a short time after our beginning attendance upon the case. We both repeatedly, and each time without difficulty, developed with the sound to our entire satisfaction the presence of a considerable calculus. Grating and clinking against the steel sound was unmistakable. The stone was movable both by the sound and on changing the position of the patient. Lithotomy was strongly urged, but the patient insisted that the alkaline mixture kept him perfectly comfortable, and stated that he "preferred taking medicine all his life to submitting to the operation." He soon passed from the observation of both of us, and for many years we had no contact with his case. Early in 1865, being called to attend his second wife, we requested him to give us the history of his case subsequent to our last interview. He stated that as we had refused to give him any more

morphine he concluded he would continue to take the alkaline mixture which had so long relieved him; that he continued to procure the medicine by the same formula, neither increasing nor diminishing any of the ingredients. He had left off medicine years ago, but has had no return whatever of vesical irritation. He insists that we must have been mistaken as to the fact that he was the subject of stone. In which opinion it is unnecessary to say he was entirely in error. Since engaged on this report we called upon our former patient, now a robust active man of nearly fifty years, engaged in the daily work of a car-builder; when he repeated this portion of his history, but refused and, we think, not unreasonably, to submit to sounding, fearing, as he said, that the use of instruments might reproduce his former troubles.

We think it legitimate to ask the question: May not the prolonged use of the alkaline preparation, nearly a drachm of bicarbonate of soda daily, for so many years, as it was known to clear the urine of sediment—may it not, we say, have also effected the gradual solution and removal of a uric acid calculus? There is no reason for believing that this patient has ever been operated on, or that he would have concealed the fact of the present existence of stone, did he still suffer from any of his former symptoms. The probability of the encystment of such a large free-moving calculus is also quite unreasonable.

The following case is one which, more than any other in our experience, or in our knowledge of the reported experience of others, seems to demonstrate almost positively the solvent properties of alkalines constitutionally administered:—

CASE XXXVII. P. B., aged about sixty years; had been for over thirty five years a citizen of Augusta, Georgia. He was stout and robust at the time of applying for treatment, but he had formerly been the subject of a mild cerebral attack—probably apoplectic; from this he seemed now to have entirely recovered. He reported that he had for some years suffered with a gradually increasing irritation of the bladder—having to rise often at night and passing but small amounts of urine each time. His urine showed decided acid reaction by litmus, and sometimes there would be found an adherent red sediment in the chamber vessel.

Taking into consideration the patient's age and the fact that he had once been the subject of a disabling cerebral accident,

we naturally regarded his vesical trouble as an annoyance by no means to be surprised at. Enlarged prostate to our mind accounted sufficiently for the irritable bladder. The excess of uric acid seemed easily explained, he being a robust man and heavy eater for one of his age, leading now a somewhat inactive life. He had as yet never required the application of the catheter to empty his bladder. The idea of vesical calculus did not for a moment occur to us.

1st.—R. Bicarb. potass. ℥iss.
Water Oj.

Mix and label "Alkaline Solution." Dose, one tablespoonful in combination.

2d.—R. Citric acid ℥j.
Water Oj.

Mix and label "Acid Solution." Write: Dose, one tablespoonful in combination.

These two solutions were taken together in a gill of water three or four times a day during effervescence; syrup of buchu being added to each draught.

The above proportions we owe to the valuable work of Dr. G. Roberts on Urinary Diseases. The device of modifying the prescription into an effervescent draught is our own. It was simply intended to alkalinize and lessen the acrimony of the urine—as we had advised it to many others. Some four or five weeks after he had been taking the effervescent draught, not having in the meantime paid him a visit, we were urgently requested to visit Mr. B. at night. He stated that the irritation had been much relieved for a time, but that, recently "he had been passing bits of gravel, that they had several times nearly stopped his water, and he thought now there was a large one in the channel, as he could pass no water at all." He exhibited several of the pieces, and they were unquestionably fragments of a uric acid calculus, angular and jagged, not specimens of a multiple gravelly deposit. Having brought with us only a gum-elastic catheter, we introduced it with some difficulty, pushing back the object into the enormously distended bladder. He had suffered with this distension for many hours. There was passed into the vessel more than a quart of dark bloody-looking urine. When the catheter was removed, a small angular fragment of the uric acid stone was lodged in one of the eyes of the instrument. We subsequently on several occasions attempted the introduction of a steel sound to explore the bladder, being now

confident that there was a large quantity of disintegrated stone in its cavity. This we found quite difficult of accomplishment on account of the greatly enlarged prostate, but more especially on account of the determined opposition of the patient. He would not consent to the use of even a silver catheter—by which we had hoped to make a less imperfect exploration. Being quite ingenious and apt, he soon learned to apply the gum-elastic catheter himself, and as he suspected that we had been in some way the cause of his present trouble—and we are glad to say we rather unpremeditatedly were—he dispensed with our daily visits and was skilfully relieved, night and morning, either by his wife or by his own hands, by means of a No. 10 flexible instrument we had selected for him.

This patient was kept continuously under the use of the alkaline draught. On our occasional visits, he would show us the gradually accumulating mass of the uric acid fragments which he was daily passing from his bladder, till over an ounce had been collected in a quinine bottle. Of course we could not fail to recognize the connection between the continued taking of this decided alkaline and the passing away of so many masses of uric acid stone. To demonstrate this relation we made the experiment of putting a considerable lump of the calculous matter into a vial containing some of the combined solutions. In less than fifteen minutes, by shaking, the entire fragment had been dissolved, leaving a clear solution without precipitate.

About this time, we were much gratified when the patient desired that we should request our friend Dr. Henry H. Steiner, of this city to visit him. Of course the interest of the case was equally great to both of us. We repeated the experiments, demonstrating the entire solubility of the fragments in the solution. We debated the expediency of injecting a weaker solution into the bladder, but as the progress of the case, however, was highly satisfactory, we delayed this experimental measure for a later period, and it was finally never attempted. The fragments became fewer and smaller till at last they have disappeared from his urine altogether. We are sorry to say, however, that this gentleman requires still the application of the catheter, seemingly on account of muscular atony, probably from frequent over-distension,¹ or possibly this obstinate atony may have had

¹ See "Self-injection of the Bladder," by W. H. Van Buren, M.D., and E. L. Keyes, M.D., New York, 1875, for valuable remarks on the subject of atony and over-distension.

its origin in the single occasion of prolonged and enormous over-distension in which he first required the catheter.

From the developments of the above case, we think we may fairly conclude that the patient had been the subject for perhaps a considerable time—since the first show of vesical irritation—of a gradually increasing uric acid calculus; that as with the advance of age and under the asthenia incident to his crippled sensibility from cerebral disease and the enlarged prostate, this stone became more obstructive than formerly. And, finally, that the persistent use of the alkaline solution caused its gradual disintegration ultimately resulting in the removal of the last particle from the cavity of the bladder.

A case almost identical with the above, and said to be related by Mr. Travers, tempts us to place it in relation with our own. A tailor, who had long labored under symptoms of stone, was sounded by Mr. Travers a few years since, who detected a hard calculus of some size, and counselled immediate operation. The man being afraid to incur the risk of the proceeding, put himself under the care of a person at Henley-in-Arden, who administered a “constitution water” to the extent of two or three pints *per diem*. The patient soon began to pass fragments in quantity as after the operation of breaking, the act being attended with acute pain, both before and during micturition. The pain and discharge of fragments continued for many months; both subsided at last and at the same time. The patient, on one occasion, showed him a box full of fragments, for the most part reduced to powder.

This man was examined after death by Dr. Charles, of Putney, and no trace of stone was discovered in the bladder.

Dr. Prout stated the basis of the “drink” to be carbonate of soda and potassa with a little nitre in the following proportions:

R.	Sodæ carb.	.	.	.	.	.	grs. x.
	Potass. carb.	.	.	.	.	.	grs. viij.
	Potass. nitrat.	.	.	.	.	.	grs. ij.

J. F. SOUTH (CHELIUS.)

It will be remarked that in each of our three cases, soda or potassa entered largely into the composition of the solvent; first, potassa in combination with alumina; secondly, the bicarbonate of soda; and lastly, the citrate of potassa—seemed each to possess the desired property of effecting the disintegration of this variety of deposit.

Constitutional Stone Solvents.—The literature of calculous diseases was, not very long since, quite rich—we may say burdened, with considerations relating to the lithontriptic methods of removing calculous deposits from the body. These have enjoyed a varying degree of confidence from the profession. From about the year 1700 to the first third of the present century, seems to be the period in which the most rational views in regard to such methods were entertained. The general result arrived at, with most seeming reliability was, that alkalies would dissolve the uric acid deposits, and acids the phosphates, though these last, it was thought, required injections into the bladder containing the stone. The brilliancy of surgical measures and the more certain and prompt relief obtained by “cutting for stone” and the still more attractive idea of “crushing,” soon dimmed the little light that was beginning to dawn, and which in time might have guided us into the occasional use of chemical methods. For the last fifty years or more they seem to be forgotten, or at least never appealed to in the removal of vesical calculus under any circumstances whatever. We would here venture humbly to suggest, in view of the significant facts furnished by our above three cases, and the one case of Mr. Travers, that possibly, with the present advanced condition of chemical knowledge, *the lithontriptic plan*, either constitutionally administered or by well-devised injections into the bladder *might be so far revived* as that it may be resorted to in cases wherein circumstances indicated both the cutting and the crushing operations to be fraught with special or unusual danger to the life of the patient. Possibly, some of those who die under lithotomy, or wear out under lithotripsy, in advanced life, might be gradually and safely freed from the burthen of a uric acid stone, by modern improvements on some of the lithontriptic methods, which our ingenious predecessors labored so industriously, yet failed so signally to establish, as “*the bloodless treatment of stone.*”

GUN-SHOT CALCULI OF THE AMERICAN CIVIL WAR.

Doubtless the lodgment of a ball or particle of bone or of wadding of cartridge, or of other foreign matter, in the cavity of the bladder, as an accident of battle, has not been a mishap of very infrequent occurrence during the late war. Besides the two rather remarkable cases of this kind reported in the present catalogue, we were cognizant of two more that came to our

knowledge during the time of hostilities, and a few others which have been brought to our attention in a letter, referred to us by Dr. Mastin, from Dr. Otis, of Washington.¹ The two above mentioned were in the hands respectively of Prof. A. E. Peticolas, of Richmond, then surgeon of hospitals at that post, and the other was an operation, we understand, of Prof. Paul F. Eve's, of Nashville, then military surgeon in charge of hospitals in Augusta, Georgia. In the case of Surgeon Peticolas, the lateral operation was at once performed, and a considerable buck-shot was removed from the bladder of a Confederate soldier, on his arrival from the battle-field. There was no calcareous deposit and the case made a good recovery. A longer time had elapsed in Dr. Eve's case and calcareous incrustations had formed, to a moderate extent, before the removal of the lead.

The two following cases of gunshot calculus will be found, we think, to present some points of interest beyond the mere novelty and paucity of such records.

*Gunshot Calculus—Nucleus, a minie-ball—Bilateral lithotomy.—
Recovery—Calculus over a quarter of a pound in weight.*

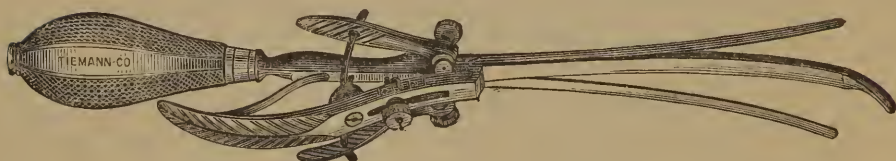
CASE XXXVIII. Private W. B. Griffiss, a Confederate soldier, aged twenty-five years, a resident of Abbeville District, S. C., was wounded on the third day of the battle of Gettysburg, July 3, 1863. At the time of examination he was the subject of a distorted and shortened union of a fracture in the upper third of the right femur. He stated that the fracture was produced by a minie-ball wound received at Gettysburg, and that he had suffered from symptoms of irritation in his bladder, and more or less trouble in making water, from the first moment of receiving his wound until the present moment. On its being suggested to him that the ball had probably lodged in his bladder, he promptly replied, that this was impossible, for it was removed, in a mashed and flattened condition, from a situation near the fracture, at the time his wound was dressed by the surgeon on the field. For many months he had been unable to retain his urine. It dribbled away involuntarily from the urethra both night and day. He was pale, emaciated, and exhausted from

¹ See *Boston Medical and Surgical Journal*, Feb. 7, 1878, p. 163. Art. "Notes on Contributions to the Army Medical Museum," etc. By George A. Otis, M.D., etc.

loss of rest and protracted suffering. On the introduction of the sound, a large calculus was found to occlude the entrance of the bladder, and it could also readily be felt to be fixed in this situation, by passing the index finger into the rectum. The sound could, however, be pushed on, without the exercise of any imprudent force, so as to be passed under the stone into the lower fundus of the bladder. The sound could here be felt from the rectum, between the under surface of the stone and the intervening walls of the two cavities. It was quite large and evidently irregular in contour. One of the prolongations very plainly occupied a fixed position in the neck of the bladder.

January 22, 1868. Bilateral lithotomy was performed at the City Hospital in presence of the class of the Medical College of Georgia, and assisted by Prof. Edward Geddings, Dr. J. S. Coleman, Drs. S. C. Eve and R. C. Eve, and others. Fully appreciating that we had a large and irregular mass to extract, Dupuytren's Adult Double Lithotome was set to very nearly its full adult size (Fig. 1). For the preliminary curved incision in

Fig. 1.



front of the anus, we mention here, we always prefer, as most convenient, a short, straight knife with a round blade, not over an inch in length. With the forefinger of the left hand kept in

Fig. 2.



the rectum and the thumb pressed on the raphé, we carry this blade repeatedly, if necessary, in a curve in front of the thumb, till the plane of the grooved staff is nearly reached. When the groove can be distinctly felt, we cut, with the same knife, a half-inch longitudinal incision, and *keep the nail of the left index in this incision until we are sure our beak has glided along the groove into the bladder.* We have seen Dupuytren's operation fail, in otherwise skilful hands, for the want of this particular manage-

ment of the nail of the left index finger. We shall not, perhaps, in any case hereafter refer to any habit of our own in the performance of this well-known operation. On making the backward cut with the lithotome, we attempted to remove the stone by the forceps, but found it impossible to move it, so firmly fixed was it behind the symphysis pubis, the bladder being contracted down upon it. The opening could not be dilated sufficiently, either by tearing or stretching, to extract the wide-spreading calculus. A narrow, probe-pointed, curved bistoury was now conducted along the palmar surface of the index finger of the left hand to the commissure first of the right and then of the left incision in the bladder and prostate gland, and thus the lithotome-cut was carefully extended on both sides. The large, irregular mass was even now with difficulty extracted. One of the angles, to be described hereafter, was broken off and had to be taken out separately. The patient did not lose any serious amount of blood, but we find on our record of the case, that "the shock of the operation was very great."

January 26th. Patient doing well. No hemorrhage—urine flowing freely through the wound—some has passed several times through the urethra. Fig. 3¹ conveys a good idea of the contour and dimensions of the stone extracted in the foregoing operation. Its weight was *over a quarter of a pound*—four ounces and four drachms avoirdupois. In shape it more nearly resembled a very large meerschaum pipe than anything else we can liken it to. The expanded portion, representing the bowl of the pipe, had evidently rested in the cavity of the bladder, having been there moulded in contact with the mucous membrane against its anterior wall behind the symphysis and body of the pubis, while the narrower elongated portion, more than an inch and a half in length, and of the size of a man's thumb, had accumulated and rested in the neck of the bladder. In composition, it evidently belongs to the class of ammonio-magnesian phosphates, though, as yet, no careful analysis of it has been made.

Fig. 3.



Section of a vesical calculus formed about a fragment of a musket ball. Specimen 6732, Army Medical Museum, $\frac{1}{2}$.

¹ From Dr. Otis's paper in the *Boston Medical and Surgical Journal*, Feb. 7, 1878, p. 169. See also Fig. 5, specimen with Bone Nucleus.

Considering his low condition and the rather severe character of the operation, Griffiss made a rapid recovery. He left the hospital in twenty days, and returned to his home in Abbeville. Forty days after the operation, he (quite imprudently, we think) began the work of ploughing his land for a crop. We did not learn, however, that any evil consequences resulted from this premature resumption of hard labor. On carefully inspecting this calculus; its origin and history are clearly revealed, while its situation, contour, and certain other peculiarities are quite satisfactorily accounted for. Notwithstanding the confident and unquestionably sincere statement of the patient, it is very apparent that the minie-ball, or at least a very considerable portion of it, had found its way into the bladder at the moment of the wound, that it must have gravitated towards the outlet or neck of that viscus, and that it had there remained clasped edgewise in the passage—partly in the cavity of the bladder and partly in the cavity of its neck—probably since July 3, 1863. All the wounds had closed, as there were no fistulous tracks, at the time we examined him, for either pus or urine in either the thigh or pelvic region.

Such was the nucleus of this gunshot calculus so far as can be ascertained by simple external examination. It is evident that the weight of this portion of the ball, flattened on its way to the bladder by contact with the femur at the seat of fracture, kept it immovably fixed in its situation. The urine at first passed out in a channel divided by the edge of the septum it presented. The calcareous salts, it is probable, began at once to be precipitated on all the surfaces which could be bathed by the urine. This contact of urine and deposit of salts was effected upon every portion of the leaden disk except on the very lowest edge, where with its weight and possibly some *jamming* it rested upon the floor of the bladder and lower wall of the urethra. Here the lead is devoid of calcareous covering and can at any time be readily brightened by scratching with the nail. The precipitation progressed, doubtless, comparatively slowly at first; but as a larger and larger surface was being constantly presented, probably thereby adding to the irritation, while the same *contour and proportions* were maintained, the *dimensions* increased in geometrical progression; till, in the comparatively brief period of about four years and six months, the enormous

weight of over a quarter of a pound had been attained.¹ The breadth and circumference of this leaden nucleus we cannot give for the obvious reason that we are unwilling to run the risk of injuring or perhaps destroying so remarkable and valuable a specimen. As a physiological *experiment* made on the living human body, the observations pertaining to this case and to the one following may, perhaps, in their own restricted way, be humbly compared, in the matter of *opportunity*, to those of Dr. Beaumont, as made in the case of the wounded soldier, Alexis St. Martin. Such opportunities have been but rare, and we are fully aware that time has not been allowed us to utilize the many valuable deductions with which such unusual phenomena are richly endowed. Such are the facts, however, and we can only hope that, pregnant as they may be with important results, they may be made useful by others in attaining clearer insight into the mysterious influences guiding and controlling the rate and character of calcareous accumulations precipitated from human urine under local irritation.

Scarcely less interesting, and much more remarkable in certain particulars, will be found the experimental aspects of our second case of gunshot traumatic calculus, also a result of the late civil war.

*Gunshot traumatic calculus—Nucleus, a fragment of pubic bone—Urinary fistula in the gluteal region—Virility, nullified during the presence of the fistula and stone, restored after four years, on bilateral lithotomy.*²

CASE XXXIX. M. J. C., colonel of a South Carolina regiment of the Confederate army, a married man aged about thirty-five years, the father of four children—the youngest an infant at the time he received his wound—was wounded at the battle of Malvern Hill, July 28, 1864. His residence, before and after the war, was Barnwell District, South Carolina.

September 26, 1868. On careful examination of Col. C.'s case, we found, that the ball had entered in front, somewhat to the

¹ See water history of this stone on subsequent page.

² A synopsis of this and the foregoing case was published in the *Boston Medical and Surgical Journal*, Feb. 7, 1878—"Notes on Contributions to the Army Medical Museum by Civil Practitioners," by GEORGE A. OTIS, M.D., Assistant Surgeon United States Army, Curator of the Army Medical Museum. Our illustrations are from his delineations. The calculus was bisected by Dr. Otis.

left of the symphysis pubis; that, perforating the body of the bone and traversing the bladder, it had passed out near the fold of the right buttock. At the time of our examination, he was suffering from extreme and constant vesical irritation. He passed but little urine through the urethra, but voided most of it through a fistulous opening near the fold of the right buttock, which opening was the wound of exit terminating the track of the ball which had traversed the body. He stated that there had been periods when the track appeared to have healed, and when all the urine passed naturally through the urethra. This, however, had not taken place now, for many months; the urethra seemed almost entirely closed, for only a little water dribbled away from this passage at the time of his efforts to pass urine, while nearly all of it was voided at the opening below the hip just mentioned. He seemed, however, to have pretty fair control of the passage of water, as he could retain the urine generally until he "was called on" to void it; at which time, as above stated, it passed almost wholly through the wound. The pubic wound was indicated only by a scar. He was greatly emaciated from imperfect nutrition, constant suffering, and frequent attacks of irritative fever. Compulsory sexual continence existed from the day of his wound to the time of the present examination. *His youngest child was, at this time, some months over four years of age.*

The rational symptoms of stone being present, though, considering the broken condition of the bladder, by no means necessarily indicating the existence of stone, an examination with the sound was made. A calculus of considerable size was at once detected at the very entrance of the bladder. It being firmly grasped by the circular fibres of the neck must have interfered, very decidedly, with the exit of the urine. He stated that he had never experienced trouble of any kind with his bladder, until struck by this ball; but from the very moment of his wound, the pain had been constant and distressing. With our recent experience in the case of Griffiss, we naturally suspected the lodgment of the ball in the bladder, but the patient assured us that this was impossible, as the entire minie-ball had been cut out from under the skin in the situation of the posterior wound, the track not being complete.

September 28, 1868. Assisted by our friends Dr. J. S. Coleman, Prof. Edward Geddings, Dr. Sterling C. Eve, and others of this

city, we performed ordinary bilateral lithotomy. The hemorrhage was not unusual at the time, and the stone was readily dislodged from its rather fixed position in the neck of the bladder. It is oblong in contour, its dimensions being about two and a half by one inch. It seemed to us rather light for its dimensions, weighing only one ounce and one drachm. It is soft, friable, and chalky. Upon testing it rather hastily, we concluded that it belongs to the class of ammonio-magnesian phosphates, as it dissolves very readily in weak nitric acid.

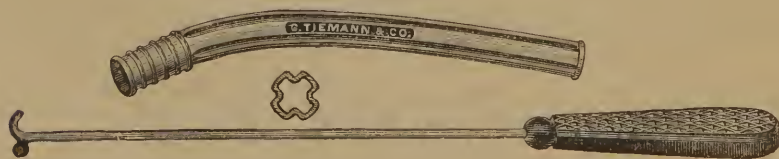
October 8th. The tenth day after the operation a sudden, profuse, and alarming hemorrhage occurred. We found the patient greatly exhausted—cold, clammy, and with a pulse almost imperceptible. The bleeding began while he was asleep; and, on waking, he found himself lying in an immense pool of blood. We quickly tore open the wound, on entering the room, by thrusting the index finger into the almost cicatrized cut; the finger fitted tightly, and the blood, of course, was under complete control till the *tampon en chemise* could be prepared. This was thrust into the wound and carried up well into the bladder, on the removal of the finger, and then the packing around the tube was firmly made with cotton, saturated in a pretty strong solution ($\frac{1}{2}$ oz. to Oj.) of Monsel's salt. There was no further bleeding. We have seldom felt greater apprehension about a hemorrhage, and therefore did not remove the tampon until the third day. The wound rapidly contracted again, and the case made a fairly prompt recovery. The fistulous ball-track had entirely healed before the patient left his bed; indeed, there had been no urine discharged from the buttock from the time of the perineal incision. It is our opinion that, as in the case of Sanders, Case XXIV., the artery of the bulb, and *not* the internal pudic, was here again the source of bleeding.

The grooved tampon en chemise—For arrest of hemorrhage in perineal lithotomy.

This instrument or apparatus, as heretofore and at present used and depended upon, has certain deficiencies which render it objectionable and unreliable for the arrest of a serious hemorrhage. It consists essentially of a tube some three or four inches in length, slightly curved near the vesical end and grooved circularly to retain the winding of the cord to hold the cloth or *chemise*. This tube, properly surrounded by the *chemise*, is intro-

duced through the wound into the bladder and then packed with cotton or sponge, saturated with some styptic lotion, to assist the compression in arresting the hemorrhage. The objection that we have found to this instrument is that the surface of the tube is smooth and rounded. In pushing in the saturated cotton with the *porte-mèche* it slips to one side or the other, and the packing is with difficulty placed accurately in the locality of the bleeding vessel, which, as we have said, is most frequently the artery of the bulb near the upper end of the wound. This point is the one, with the present form of instrument, most likely to be left unpacked and the artery uncompressed, so that the bleeding is apt to continue. To remedy this most dangerous defect in an instrument upon which the life of the patient often depends, we have devised what we have found an important improvement. In our instrument, made for us by Messrs. George Tiemann & Co., of New York, there will be found a deep groove upon each quarter of the tube rather more deep upon its upper side on account of the *bulbar artery*. Into this groove, when the packing is to be made between the tube and the *chemise*, or cloth—fine bolting cloth being the best—we lodge the lower fork of our *porte-mèche*, armed with the cotton, and push it on to the vesical end of the tube. This is repeated till on every side a sufficient number of pledgets of the styptic cotton is pushed up to pack well and firmly the entire wound from the vesical to the cutaneous end of the track. The grooves along the four sides of the tube serve to keep the fork of the *porte-mèche* steadily in the proper direction till it is well packed in on every side of the tube.

Fig. 4.



Campbell's Grooved Tampon en Chemise, and Porte-mèche with soft shank, for packing.

As a necessary attachment, we must have a *porte-mèche* made to accompany the tube, the forks being olive-pointed and smooth, so as not to tear the tissues or hitch in the *chemise* while the packing is being pushed on. We think that when the *tampon en chemise* has heretofore failed to arrest the bleeding, it has

been from the imperfect packing caused by the want of the groove, which we have now added, to direct and make accurate the compression upon the bleeding vessel. We have kept the instrument in the wound for several days, and it has served us well in a few most frightful hemorrhages, both primary and secondary, following bilateral lithotomy.

Though by the record of our own cases the proportion of deaths has been but two out of forty-nine under the various operations of lithotomy—principally the bilateral—still, according to the most recent estimates, *one out of three* for adults is the proportion of fatal results. It is known that this frightful mortality is largely due to hemorrhage, the accident which renders the operation so dangerous in the adult.

In view of the great fatality attending lithotomy at one time, bloodless evacuation of the bladder by crushing instruments became a great desideratum, and Civiale, in France, became the founder of the then new school of lithotrity. Among the earlier followers of Civiale, no one in this country more ardently advocated the method, or was more successful, than our distinguished friend and colleague, L. A. Dugas, M.D., Professor of Surgery in the Medical College of Georgia. Located in a region not highly productive of calculus, his list of operations yet comprehends thirty cases.¹ In this list there is but one negro. One, an infant of *six weeks*, in which the calculus, size of a grain of wheat, was obstructing the urethra, and was removed by dilatation. Of "twenty-nine cases, eighteen were treated by Dupuytren's bilateral method, and seven by urethrotomy and dilatation." Four of Dr. Dugas's earliest cases were relieved by lithotrity, the operations being successfully performed at a time when Civiale was scarcely known and his method but little appreciated in America.² In later times, Sir Henry Thompson³ in England, and Prof. Bigelow⁴ in this country, have each greatly advanced the facility as well as the safety of this practice.

In the rapid strides made very recently in the methods of

¹ These cases have been collected but recently. They will be found in the Transactions of the Medical Association of Georgia, volume for 1874.

² The Report of the Commission of the Academy of Medical Sciences on Lithotrity is dated Paris, March 22d, 1824.

³ Practical Lithotrity and Lithotomy, London, 1871.

⁴ Litholapaxy, or Rapid Lithotrity with Evacuation, Boston, 1878.

lithotrity, we may hope soon to find lithotomy in the adult almost a procedure of the past. During the past two years Prof. Henry J. Bigelow, of Boston, has interested the profession by communications on the subject of "Rapid Lithotrity with Evacuation," through the *American Journal of the Medical Sciences* and the *Massachusetts Medical and Surgical Journal*. For the volume entitled "Litholapaxy," in which his views are carefully systematized, we here render grateful acknowledgment.¹ It is here made clear that in a large majority of cases in the adult, litholapaxy will supersede lithotomy, with a great reduction in the mortality of treatment. There will remain, however, many cases in which lithotomy will still be performed, and in these the almost inevitable occurrence of hemorrhage will give great importance to any instrument by which very nearly infallible control may be exercised over the bleeding so fatal in adult operations. Such an instrument we have found in the grooved *tampon en chemise* herein suggested by us, and which we now for the first time present to the profession.

A *nucleus of bone* was found in the centre of the calculus on sawing through its longitudinal diameter. The structure seems to be compact, and the surface exposed on each half of the divided stone runs longitudinally about one inch, and is nearly one-eighth of an inch in thickness. As it is embedded in the calculous matter,² its breadth cannot be ascertained without completely destroying the specimen. We may safely account

for its presence in the bladder by the inference, that it is a portion, probably, of the posterior table of the body of the pubis, which was driven in and left in the bladder at the time that the ball passed through, splintering it off as in passing through a plank. Like the fragment of minie-ball in Griffiss' case, it had been soon carried to

the neck of the bladder and lodged in the outlet. At this place, the precipitation of calculous matter had gradually accom-

Fig. 5.



Vesical calculus formed about a nucleus of bone. Specimen 6733, Army Medical Museum, $\frac{1}{2}$.

¹ As also for the following valuable papers: Lithotomy, by Reuben A. Vance, M.D., of Gallipolis, Ohio; reprint from the *Cincinnati Lancet and Observer*, March, 1877: Median Lithotomy, by Prof. J. H. Pooley, Columbus, Ohio: The Operation for Stone, as observed in the London Hospitals, with Seven Lithotomies, by Prof. A. Van Derveer, M.D., of Albany, New York.

² From the *Boston Medical and Surgical Journal*, Feb. 7, 1878.

plished the almost entire occlusion of the opening. On this account, it may be concluded, it was that the recently healed wound in the wall of the bladder and also the entire track of the ball had again become fistulous by reopening to give exit to the urine. As to the number of cases like the above, that have been operated on and recorded during and since the war, we have no ready means at present of ascertaining: we said, in the paragraph introducing our two cases just related, that we supposed that the lodgment of a ball, or a particle of bone, wadding, cartridge, or other missile in the cavity of the bladder, has *not* been a very rare mishap during our late war. Two cases of the kind, occurring to us, would rather indicate this opinion to be just.

A letter from Dr. George A. Otis, of Washington, referred to us May 8, 1876, by our friend, Dr. Claudius H. Mastin, of Mobile, seems to establish the fact that there are a number of such specimens in the collection of the National Museum. Dr. Mastin writes us, "Dr. Otis has, to this date, *all* the specimens of that kind, with the exception of one in Ohio, and *that will* be placed in the general museum. These are the only specimens now in existence, and they should be placed together."¹

EFFECT OF LITHOTOMY ON SUBSEQUENT VIRILITY.

On account of the alleged injury sustained by the vesicles and ejaculatory ducts, subsequent loss of virility has been urged against the bilateral operation, though Dupuytren himself held the ducts to be more safe from injury than in the ordinary

¹ Apart from "the pomp and circumstance of war" we are able to refer to two other cases entirely dissimilar to each other and also to ours, where *bone* became the nucleus of calculous concretions; our friend and relative, the late Prof. Paul F. Eve, of Nashville, while editor of the *Southern Medical and Surgical Journal*, in 1846, reports in the volume for that year the case of a woman, who, falling from a stable-loft, got astride a pin, and so injured herself that she was for a long time disabled." Dr. Eve performed lithotomy, and reports the case as "A portion of bone, probably of the pubis or ischium, removed after fracture, from the bladder, surrounded by a calculous mass." The vesico-vaginal operation was performed, and the woman recovered without a fistula.—*Remarkable Cases in Surgery*. By Paul F. Eve, M.D. 1857.

The nucleus of another stone in a woman is to be found in the collection of Dr. Robert Liston, of London—"a fetal tibia which found its way by ulceration into the bladder from the abdomen—the case having been one of extra-uterine foetation."—*The Urine and its Derangements*. By George Harley, M.D., F.R.S. 1872.

lateral procedure. The American Medical Association, during its session held at Louisville, Kentucky, May 1859, appointed a special committee, of which Dr. J. S. White, of Memphis, was chairman, to investigate "the effect of perineal operation, for urinary calculi, upon procreation in the male." Unfortunately we cannot refer to this report, if ever it were made, as the succeeding volume of the Transactions is not at this moment accessible. The appointment, however, is sufficient to indicate the manifest interest in this important subject. Of all the questions attaching to lithotomy, this one of *impotency* has been the one most difficult to answer to the satisfaction of all minds. However strong the case may be, in favor of the unimpaired virility of the father ordinarily, a loop is still left to hang a doubt upon, in the ungenerous and generally unfounded aspersion of the faithfulness of the mother. "Vicarious paternity" is, to the minds of these recusants, unwarrantable as the unkind suggestion may be, the yet unanswerable explanation given to the continued fruitfulness in the family when the father has undergone bilateral lithotomy.

In a former case, XXII., we were careful to state the circumstances under which impregnation was alleged to have been due to a patient, after recovery in the hospital from the operation; they, we admit, materially vitiate the reliability of the inference. In our present case, however, besides the most spotless character of the mother, we have a history of detailed events which, as by moral certainty, fully establishes the procreative power of the father, after recovery from quite an extensive bilateral cut:—

A young woman, of perfect health, bears children rapidly up to the period that her husband receives his disabling wound; a large calculus and the extensive urinary fistula interrupt sexual relations for over four years and four months at least; the last infant at the time of operation, several months over four years of age, is still their youngest child. The husband rapidly recovers after the operation, becomes robust, active, and cheerful. Child-bearing is at once resumed; a child is born within a year after the operation, and the rate of increase in the family since has been similar to that which existed previous to the gunshot wound. Was there ever more complete vindication of the loyalty of the wife or better proof of the unimpaired virility of the husband?

The above particularity may be considered by some wholly unnecessary; to our mind this is by no means the case. One

positive and unassailable fact, in a question so difficult to solve, possesses a value that is inestimable, even though that value extends no farther than to establish the negative—as we in all fairness are bound to admit—only in a restricted degree, viz., that bilateral lithotomy does not *in every case* injure the procreative power of the patient. Our valued friend and able colleague on the State Board of Health, Dr. F. A. Stanford, of Columbus, has within the last year or two reported, through *The Atlanta Medical and Surgical Journal*, his experience in about twenty operations of lithotomy. Like ourself accident determined his adoption of Dupuytren's procedure in his first operation, and a perfect satisfaction with his success caused him to adhere to the method. Aware of the alleged injury to virility charged against the operation, he mentioned several of his cases which go far to disprove that such injury is a common result. He states that "he has operated on men previous to marriage who afterwards became fathers of families, and that also, operating upon husbands, he found in their cases no interruption to the increase in their families." Many of our own cases came to us from a distance; others have passed from our observation. We have above reported the only two of which we have been able to gain particular knowledge in the matter of procreative ability after bilateral section.

As this paper is undergoing correction for the press, the following private note is received from Prof. F. L. Parker, of Charleston, S. C.: "*Apropos* of stone. I will now furnish you with one of your own 'forgotten cases'—one *not sterile*; has had four children. This makes two of our nine cases of yours successful and having issue. Why not trace out the history of some others, and solve the question of sterility after stone?" Dr. Parker continues: "Dr. Wm. J. Young, of Campbellton, S. C., sends me three new cases. One of yours, as follows: 'W. B. Sanders, white; always lived in Barnwell, S. C. By Dr. Henry F. Campbell, in Augusta, May, 1869, but not among the cases given you by him. In a year or two after operation, married, and is the father of four children. No further symptoms of stone. Have known him for six years.'" Case XXV. of the present paper is the one above referred to. It was overlooked in the list furnished Dr. Parker.¹

¹ "A Compilation of One Hundred and Thirty-one Cases of Stone in the Bladder in South Carolina, with Operations," is the title of a valuable digest of all lithotomies performed anywhere on calculi originating in South Carolina.

THE RATE OF CALCULOUS PRECIPITATION.

35 The rapidity or the slowness with which calculous accumulations are deposited has seldom been the subject, even of note, much less of etiological investigation by writers on urology. There can be no doubt that a careful examination of the reports of cases, guided by the object of establishing the rate at which accumulations progress, would result in the finding of a large number in which the time elapsing between the date of introduction of the nucleus and the removal of the stone could be unquestionably established, and thereby the data furnished by which reliably to estimate *the rate of calculous deposition*. In case No. XXXIV. of this report, we regretted that no account could be given of the periods at which the wax bougie had been broken in the bladder, though by it we ascertained that in a period of not more than five years, considerably more than one ounce of uric acid concretion, besides that lost after the disintegration, had gathered round the foreign nucleus. There can be no doubt that this rate of deposit will be found to differ in individuals, and, could experiment attest the fact, to vary according to certain circumstances and several occult influences in the same individual during the sojourn of the nucleus and stone within the cavity of the bladder.

Every one with the least experience is familiar with the rapidity with which catheters, both metallic and gum elastic, become coated if left in the bladder, hence the recommendation of their removal and replacement every four or six days lest they scrape and injure the urethra when withdrawn. No particular kind of object appears to possess advantage over others in the rapidity with which it will *excite* calculous deposition. There can be no doubt, however, that such objects as *produce most irritation* are those which become most rapidly covered; after being covered, all differences are equalized and the *rate* of production, we would think, would be the same, other things being equal, whatever might have been the nature of the nucleus originating the stone. One of the most rapid accumulations of

This rich collection most surprisingly vindicates this State from the *low rate* of calculous production hertofore allowed her by all statisticians. The thanks of the profession are certainly due to Prof. Parker for this valuable and painstaking report. It will be seen that in Case ~~XL~~^{XLII} we add one more to this South Carolina list—performed since its publication.

a very large amount of calculous matter in a brief period is said to be found among the specimens in St. Thomas's Hospital. A female catheter had escaped from the hands of a surgeon into the bladder; fearful of getting into trouble, he said nothing about it, and "*some months after the woman had symptoms of stone.*" She was cut by Sir Astley Cooper, and a good-sized stone, *about an ounce in weight*, had formed around the catheter near its middle; the catheter lay across the bladder and its ends were pretty tightly fixed. Another case of Sir Astley's is reported in which *in a few months* after the entrance of a pin in the bladder of a child, he removed a stone by lithotomy. The weight of the stone is not given, and the rate of deposit cannot be estimated. From this it is clear that, with a little trouble, many cases might be found, in the records of the operation, bearing distinctly on our subject. In each of our own two cases of gunshot traumatic calculi, the date of introduction of the nucleus is accurately recorded in the date of the battle in which the subject of stone had been wounded, while the date of removal by lithotomy marks the termination of the period during which a given amount of calculous matter had been in process of accumulation.

In Case XXXVIII. private Griffiss was wounded July 3, 1863, at which time the fragment of minie-ball was lodged in his bladder. He soon returned to Abbeville District, S. C., where he remained partly confined to the house, but more often about his farm, till the time of the operation, January 22, 1868, a period of *four years six months and nineteen days*, at which time the accumulation by weight had amounted to *four ounces and four drachms avoirdupois*, and in composition was probably phosphate of lime. In Case XXXIX., Col. C. had the bone-nucleus driven into and deposited in his bladder in a gunshot wound received July 28, 1864. He returned to his home in Barnwell District, S. C., where he remained nearly the whole time confined to bed, until the time of the operation, September 28, 1868, a period of exactly *four years and two months*, at which time the accumulation by weight amounted to *one ounce and one drachm troy*, the composition being according to our test the ammonio-magnesian phosphate.

In comparing the calculi of these two patients, that formed upon the flattened fragment of ball in the bladder of Griffiss is, in addition to difference in composition, just *four times* the weight

of that of Col. C.'s formed upon a fragment of bone, in very nearly the same period of time. Under circumstances so nearly identical so remarkable a difference in the rate of calculus precipitation must necessarily suggest some inquiry as to its cause.

To those who regard renal and vesical concretions as being due to the mineral elements of the drinking-water of the subject, the chief inquiry will relate to the geological differences of these two regions. These differences are not sufficiently marked, on such a theory, to account for the facts. Abbeville and Barnwell are both river counties of South Carolina, located upon the north side of the Savannah, and less than one hundred miles apart. There is nothing in the geological constitution of the soil (both being we think principally alluvial), of either of them, upon which we could found the expectation, *a priori*, that calculous concretions would be from this source produced. Abbeville, the locality in which the largest concretion was formed, having as its chief constituent one of the salts of lime, we are told by those familiar with the soil, is remarkably free from all calcareous elements, and this patient is the only one who has consulted us for stone from that locality; while Barnwell, where the much slower deposit took place, though by no means a limestone region, is of the two less free from mineral products, certain tertiary or quarternary formations being sparsely scattered throughout various localities of this county. Though throughout this county, as well as throughout Abbeville, "soft water" is the only percolation of the soil, our patients from this region have been the more numerous and some of them remarkable for their diathetic characteristics. Three others besides the case of Col. C. are found upon our list and carefully recorded in our notes of operations. Two of these of very deep interest, but one particularly, O'Bannon¹ to be mentioned hereafter, presents an instance of the most abundant and persistent elimination of ammonio-magnesia and lime we have ever witnessed, and was marked by a rate of calculous precipitation far more rapid than any known to us in the records of surgery.²

¹ See Case XL.

² We have with great trouble been able to secure specimens of the drinking water from the *very wells* and springs used severally by Griffiss in Abbeville, and Col. C. in Barnwell, and find scarcely a trace of lime in either of them. We have these specimens still.

Water History of a Calculus—four ounces and four drachms in weight, accumulated during four years, six months, and nineteen days.—Case XXXVIII.—J. B. Griffiss.

We here detail the process by which the test was made for lime in the water, we may say, *exclusively* drunk by Griffiss during the formation of his stone. The delicacy of the test by solution of ammonium oxalate may easily be proved: According to Frederick Hoffman, ordinary aqua calcis contains only three-fourths of a grain of calcium oxide to the ounce of distilled water.

Process.—To test the delicacy of the chemical, we add four drops of lime-water to half an ounce of distilled water, shaking it well in a clean tube. On the addition of four drops of our solution of ammonium oxalate, a milky turbidity immediately took place, followed soon by a plainly perceptible deposit of lime.

Measuring out carefully into a clean tube half an ounce of the drinking-water to be tested in Case XXXVIII., four drops of the same reagent—ammonium oxalate—were added and well shaken. No effect whatever was produced upon the clearness of this water. After standing for hours there was no precipitate.

From the above result, we may consider the absence of *lime* as proved beyond question.

By the Soap-Test.—Fifty cubic centimetres of the same drinking-water were accurately measured from a graduated pipette into a clean vial: To this, c. centimetres of the standard soap-solution were gradually added (with shaking), to the point of producing a permanent lather. We found that the soap was continually destroyed, and no lather appeared until eleven centimetres of the soap solution had been added to the water—at which stage of our process the lather was permanent.

The above then indicates that this drinking-water, though devoid of any trace of lime (as just proved), is yet what Clark would call, “of eleven degrees of hardness.” This hardness doubtless depends upon the solution of the salts of magnesium and possibly other mineral solutions. The supposed composition of the stone (ammonio-magnesian) would rather confirm the supposition that the hardness of the drinking-water is due to magnesia. This magnesia probably contributed to the supply of the precipitated salts under the vesical irritation caused by the fragment of ball.

Conclusions.—From the analysis of the drinking-water in this most remarkable case, we may be led to conclude that, on the retention of an irritating nucleus in the bladder, whether idiogenic or foreign, other things being equal, mineral ingredients in the drinking-water, even as low as eleven degrees of hardness, must greatly accelerate the process of calculous precipitation.¹

As this is perhaps the most convenient connection in which we can refer to the effect of drinking-water upon the genesis of stone, we venture to anticipate our full report and briefly here epitomize a few points in the case of O'Bannon just mentioned in connection with that of Col. C., asking the reader to bear in mind that Barnwell District, though not entirely devoid of traces of lime in its soil, manifests nowhere, either in wells or springs, the slightest indication of mineral solutions of any kind.

He had lived in Barnwell to the age of fifty years, when under circumstances to be mentioned hereafter, he was lithotomized January, 1849, by Dr. Paul F. Eve, who removed $4\frac{1}{2}$ ounces of phosphate of lime. Returning to Barnwell he lived there a little over ten years, when he required his second operation. H. F. Campbell removed two ounces and two drachms by lithotomy July, 1859. Recovering, he again lived nearly four years at his old home when, becoming troubled with stone, he sought Dr. Eve in Atlanta, who in the third operation demanded by this patient April, 1863, removed eighteen calculi similar to those that had been removed in the two preceding operations. The aggregate weight is not given, but we may fairly estimate the amount safely at half an ounce, thus summing up in all about seven and a half ounces, the result of a persistent elimination of limy phosphate from the blood of the patient continued during a period of thirty-nine years.

During this entire period, as was the case with Griffiss and also with Col. C., did O'Bannon use water that was pure, and soft and entirely free from all calcareous salts—Let us ask, could the catchments of cretaceous Norfolk in white-cliffed Albion,²

¹ For the careful preparation of our reagents, and for most valuable assistance in the conduct of the above processes, we again make our acknowledgments to Mr. J. W. Pauknin of this city.

² "Not only here," says Prof. Huxley, "but over the whole county of Norfolk, the well sinker might carry his shaft down many hundred feet without coming to the end of chalk; * * * while on the shores of Kent, chalk supplies

or the lime sinks of Kentucky, or the shell-conglomerate regions of Florida, supply water that would crystallize more rapidly or into larger calculous concretions, after draining through the human blood and kidneys, than we find in the cases of Griffiss and O'Bannon?

That independently of the water we drink and of the soil upon which we dwell, the blood will sometimes contain the necessary elements, and that under the influence of some perhaps as yet unrecognized factor in the mysterious result, the kidneys will eliminate these elements and the bladder collect them into stone, we think no one in the face of such facts can pretend to deny.

The influence of "Hard," or Calcareous Water, in the origination of nuclei, and in the growth of concretions in the bladder and urinary passages.

No one assuming to offer a rationale for the genesis of stone, however just may be his premises or impregnable his conclusions, can afford to overlook those etiological relations which, from time immemorial, *drinking-water* has been acknowledged to bear to that mysterious process. Though, by the application of a more advanced physiology we may be able better to comprehend many aberrant facts and phenomena and to establish a lithogenesis more consistent with vital conditions than that which would liken these formations to the subterranean stalactite and stalagmite; still, the chemical considerations attaching to the water drunk and the soil lived upon, during calculous precipitation, have yet their proper and important place both as factors and conditions, and are ever worthy of the greatest weight, in all investigations pertaining to the etiology of stone.

Even prior to the time when the science of observation and chemistry had sufficiently advanced to admit of reliable demonstration, the fact was tacitly admitted that among the dwellers of "limestone regions" and the drinkers of "hard water," a larger proportion of calculus sufferers were to be found than could be produced among the inhabitants of primitive areas, who drank the pure "soft water" of granitic or silicious catchments.

that long line of white cliffs to which England owes her name of Albion."—Lay Sermons, Lectures, and Reviews. By H. Huxley, LL.D., F.R.S., p. 174.

"In Norfolk," says Dr. Cameron, "calculous disease is very common, and the waters in that county are very calcareous." A Manual of Hygiene Public and Private. Dublin, 1874, p. 80.

So striking, indeed, at one time, had *seemed* to be this almost universally admitted fact that sanitarians appeared for a considerable period to regard the proportionate hardness or softness of "potable water" as the standard of its *general* healthfulness, as undoubtedly it is, in many respects, a most available criterion of its purity. That calcareous water was considered notoriously "to produce stone in the bladder" was sufficient, quite early in the history of sanitation, to secure its exclusion as a drinking supply, from all towns and cities where "freestone water," even at a proportionately enormous expenditure of the public funds, was at all attainable. It will be seen, however, that this view is not always taken, even by sanitarians of the highest authority. "With few exceptions," says Dr. Cameron, "the new water supplies contain very little solid matter in solution, whilst the water formerly in use was, as a general rule, *hard*—that is, it contained from ten to seventy grains of solid matters per gallon. When the bills for the better supplying of Manchester, Glasgow, Dublin, and other towns with water, were before Parliament, the medical and scientific evidence educed was nearly altogether in favor of soft water as against hard water. It was, to a great extent, on the faith of this evidence that Parliament was induced to sanction the expenditure of several millions of pounds for the construction of water works. After all this, it is rather startling to find a high sanitary authority—Dr. Letheby, medical officer of health for the city of London, stating that the use of soft water in a town greatly increases the mortality of its inhabitants. In his report on the sanitary condition of London, during the year 1869, he gives a table showing the average composition of the water supplied to the metropolis during the year, and from which we learn that the proportion of solid matter per gallon varied from 18.18 to 27.85 grains. The solid matter consisted chiefly of *lime salts*, which Dr. Letheby contends render the water wholesome. He says:—

"In this country it is remarkable that whenever soft water is supplied to the people, the mortality is large, even when allowance is made for the birth-rate of the place. Glasgow, as well as Preston, Dundee, Sheffield, Plymouth, Manchester, Bradford, etc., which are all supplied with water of less than four degrees of hardness, have a mortality which ranges from 26 to 34 per 1000; while at Birmingham, Bristol, Sunderland, Newcastle-on-Tyne, Wakefield, Dover, Norwich, Croydon, Worcester, Derby,

and other places, where the waters are hard, the mortality is considerably less; in fact it may be said that in towns supplied with water of more than ten degrees, the average mortality is about 22 per 1000; while in those supplied with softer water, it is about 26 per 1000.²

“Dr. Letheby,” continues Dr. Cameron, “states that the *savans* appointed by the authorities of Paris and Vienna to decide on the quality of water to be supplied to those cities, reported in favor of water of moderate degrees of hardness.¹ One consideration seems to have powerfully influenced the decision of the French *savans*, namely, the allegation that more conscripts are rejected in the soft-water districts, on account of imperfect development and stunted growth, than in the hard. ‘And if,’ says Dr. Letheby, ‘we regard the subject from another point of view, there is the striking fact that, *as three-fourths of the earth’s surface is covered with calcareous strata, we are compelled to drink calcareous water, as if it were intended for a wholesome purpose*;’² and it may well be, as the late Professor Johnson observed, that the bright sparkling hard waters which gush out in frequent springs from our chalk and other limestone rocks, are relished to drink, not merely because they are grateful to the eye, but because there is something exhilarating in the excess of carbonic acid they contain and give off, as they pass through the warm mouth and throat; and because the lime they hold in solution removes acid matters from the stomach, and thus acts as a grateful medicine to the system. To abandon the use of such a water, and to drink daily in its stead one entirely free from mineral matter, so far from improving the health, may injure it. In fact, the water of a country may determine the diet of the inhabitants. The soft water of the lakes of Scotland, for instance, may have had much to do with the use of brown meal; and but for the calcareous waters of Ireland, the potato could not have become a national food. Looking, therefore, at the plain teachings of all this, and considering the excellent quality of the water supplied to this metropolis (London), it would be folly, in my opinion, to change it for a soft water.’”

With somewhat of perplexity and dissatisfaction, which it

¹ This term “degrees of hardness” refers to the amount of earthy elements contained in solution in any given specimen of water, as determined by a “standard soap-test” to be described hereafter.

² The italics are ours.

appears to us, in a spirit of blunt candor, he is willing shall be seen, the learned and distinguished medical officer of health for Dublin thus discusses the unexpected, but yet well sustained and almost convincing arguments of his London colleague and contemporary:—

“The citizens of Dublin,” he complains, “have recently expended nearly half a million sterling in supplying themselves with water of about two degrees of hardness, instead of the water of from fifteen to twenty-two degrees of hardness, formerly in use in this city. If Dr. Letheby’s view be correct, the inhabitants of Dublin may justly complain that, acting upon the advice of scientific men, they have been led to worse than useless extravagance. It seems, however, strange that the use of pure soft water could be the means of largely increasing the death-rate of a town. The ordinary food which we use contains abundance of mineral substances, with which the bony structures of the body are nourished. Even if it did not, the quantity of useful earthy matter taken into the body through the medium of water, would be inadequate to subserve any useful purpose. (?) Let us take the case of an average sample of hard water supplied to London. It contains 16 grains of earthy salts per imperial gallon (70,000 grains weight, or 160 ounces). Few persons drink more than half a gallon of water per day, so that a person consuming that large quantity would derive from it only eight grains of earthy salts. It must be borne in mind, too, that by heating water, the hardness of which is due to the presence of calcic carbonate, a large proportion of the earthy salt is rendered insoluble. Much of the lime contained in the hard water used for domestic purposes is deposited in the tea-kettles, and other appliances of the household. *The quantity of lime in a man of 160 lbs. weight is about one pound, and an adult daily consumes in his food at least $\frac{1}{4}$ oz. of earthy salts.*”

“As the lime contained in the bones is associated nearly altogether with phosphoric acid, and not with carbonic acid, it is evident that the chalk contained in hard waters cannot contribute (?) at least in an important manner, to the nutrition of the body.

“The apparent relation between the death-rate and the nature of the water supplies in the towns mentioned by Dr. Letheby

¹ The italics are ours.

is certainly remarkable; but I think the rates of Glasgow, Manchester, and other towns supplied with soft water, were not lower when the water furnished to them was hard. Dr. Letheby includes Dublin amongst the towns which have a very high death-rate; and yet, until very recently, that city was supplied with water of about the degree of hardness which Dr. Letheby considers desirable. So far as my observation extends, I am clearly of opinion that the substitution of the pure soft water of the Vartry for the hard water supplied by the canals, has produced an improvement in the public health." He finally refers to and quotes from Dr. Gairdner, late medical officer of health of the city of Glasgow, who was also the author of an excellent work on air and water. "The Highlanders and islanders of Scotland, who, despite many unfavorable circumstances, enjoy the credit of a low death-rate, almost all drink soft water; and I do not know a single fact showing that soft water, in the many instances in which it has now been brought into populous places, instead of hard, has in any instance led to an increased death-rate, or produced an appreciably bad effect, when the other sanitary circumstances were good." "In Glasgow, the whole of the west-end and well-to-do population drink Loch Katrine water, and do not suffer. The death-rate of the town is affected by quite other causes."

Papers of Dr. Murray, of Newcastle, of Dr. Cadge, of Norwich, and of others, are adduced, to prove that hard waters give rise to calculi in those who drink them habitually. In Norfolk calculous disease is common and the waters of that county are very calcareous. Prof. Gamgee states, that "sheep are very liable to calculi in the limestone districts." But, fair to the very last, here is his admission about hard water and stone, leaving all advocates of the aqueous origin entirely at sea: "If calculous disease resulted from the use of hard water, then it should be very prevalent in Ireland; *but this is not the case.*"¹ The italics are ours.

Much that is of inestimable value could be brought in relation with our studies in lithology, from that comparatively new but rapidly extending science of sanitation, which would illuminate some of the many dark corners heretofore left necessarily

¹ *A Manual of Hygiene; Public and Private.* By Charles A. Cameron, Ph.D., M.D., etc., Medical Officer of Health for Dublin, etc. Dublin, 1874. p. 80.

unexplored by the active but preoccupied men engaged in the practice of lithotomy. Surgery is so engrossing and responsible an art that those whose interest would be most aroused to the importance of questions relating strictly to its science, have seldom the time to enter into elaborate investigations, even for the correction or substantiation of opinions long held *sub judice*, from the simple lack of time and opportunity to decide them. As will be seen above, the energetic and enterprising activity of sanitarian investigators, working in behalf of their own special interests, *is rapidly bringing to the goal of statistical determination* that which has ever been, perhaps, the most unsettled and perplexing of all the questions pertaining to the etiology of calculous diseases, namely, the relative influence of hard and soft water upon the origin and progress of calculous precipitation.

No one, perhaps, in this or any other country or age, has labored in a more determined and philosophic spirit to bring to light the amount of influence which this one, as well as all other circumstances and conditions, exerts upon the production of calculous affections, than has our able and illustrious countryman, Prof. S. D. Gross, of Philadelphia. Occupying one of the very highest positions as a lithotomist, and for years pursuing this department of surgery in that region of all others most productive of calculous affections, a master as well in pathology as in surgery, he has brought to the inscrutable problem rare qualities of both mind and experience to second an energy and a patience which are truly astonishing. In his great work on the urinary organs will be found laid up an encyclopædia of knowledge pertaining to this entire class of diseases; but the persistent devotion with which he has given himself to the collection of facts and statistics relating to the circumstances of the production of stone, is worthy of all praise, and places at the command of the investigator a rich treasury of data by which, if possible, he may attain to truth. By direct inquiry and correspondence, by tabulation and analysis of the published reports of all cases in all times and all regions, he has comprehensively pursued his work and allowed no aspect nor relation of the subject to escape his earnest search after the true cause of calculous concretions and of the calculous diathesis. Food, air, water, climate, elevation, locality; moisture, dryness, habits of life; its coincidence in distribution with other diseases, are some of the

many aspects of the subject in which he has considered this—evidently to him—most interesting of all the questions pertaining to lithology. Others, it is probable, may have to a certain extent followed this investigation, but none that we have any knowledge of, with the same comprehensiveness and clear-sighted discrimination as Dr. Gross.

The question which has greatest prominence is naturally that which pertains to the influence of the calcareous waters of limestone regions upon the production of calculous deposits. Every State in the Union, and various regions of most foreign countries throughout the world, are diligently considered in their relations to the production of stone comparatively as to hard and soft water districts. But after all, the question is left unsettled, and the patient and impartial investigator himself, at the end of his long series of reports from every region, it would seem, of the habitable globe, finds that on account of the contradictory character of the results obtained he is only more bound than ever to extreme caution in the delivery of the all-important decision.

These are his carefully weighed but candid words upon the subject:—¹

“It will be noticed,” says he, “in reading this part of the work,”—Appendix, p. 883—“that the great stone regions of this country are, as far as it is at present known, Kentucky, Tennessee, Virginia, Ohio, North Alabama, and perhaps Missouri. In all other sections of the country the disease is either very infrequent or comparatively rare. To what these differences are due has not been determined. To my mind, it is positively certain that no one cause can or does produce them. Doubtless, a combination of circumstances is at work, but of the nature and influence of this we are entirely ignorant. If we seek for an explanation of the difference in the difference of climate, geological formation, and habits of life, we shall be disappointed; for there are really no essential variations in any of these particulars between the several States above mentioned, or between these States and those which are in a great degree ex-

¹ A Practical Treatise on the Diseases, Injuries, Malformations of the Urinary Bladder, the Prostate Gland, and the Urethra. By S. D. Gross, M.D., Prof. of Surgery in the University of Louisville, etc. etc. Philadelphia, 1855.

We regret that circumstances deprive us of referring to a later edition of Dr. Gross's works.

empt from these affections. Thus, there is no essential difference in the climate, soil, and productions of Kentucky and Indiana, or in the food, drink, occupation, and modes of life of their inhabitants; and yet in the one, as will be presently seen, stone in the bladder is very frequent, and in the other very rare. It remains for medical philosophers to inquire into the circumstances, and to unravel them, if possible, in a scientific and tangible manner for the benefit of the profession and the public." He further remarks, before leaving the subject of water and food: "How far, or in what respect the development of stone is affected by food, drink, occupation, and climate, must, for the present, remain a matter wholly of conjecture. That they do exercise an influence, and that an important one, would seem extremely probable, and yet no one has succeeded in determining its character, or the share which each of these circumstances has in the production of the malady."

THE IMPORTANCE OF OBTAINING THE WATER HISTORY OF CALCULI.

We are not aware, that to the present time, any particular attention has been given in works on lithology, to what may be called the "water history" of calculous concretions by the methodical application of *tests* to determine definitely the amount of mineral elements held in solution by the water drunk, during the calcareous precipitation of any given case or number of cases. In the preparation of the present paper, we have become aware of the great omission on our own part, in failing to record any more than the general geological character of the locality in which the deposit had begun and grown to the time of extraction. In but a few of our more recent cases have we made analysis of the particular water used by the patient and his family. This measure, though at first sight appearing to add much to the trouble of the investigation of each case of stone brought for treatment, is in scarcely any case impracticable, and in the majority of them, is one of easy accomplishment; and it is believed by us would go far to define the limits in which we are hereafter to discuss the influence of calcareous water in the production of stone. Most of the subjects being of tender years and probably delicate from this cause, from earliest infancy have never left the place of their nativity nor changed the water drunk, from the initiation of the concretion by nucleus to the

time of removal of the stone. Did surgeons but request that a specimen of this drinking water be brought, either before or after the operation, the test might be made and this important fact in the history of the case developed and recorded. Much light, we are inclined to think, will be thrown upon this obscure line of investigation into the etiology of stone, when such analyses and records shall become the constant practice of the profession.

Until a very recent period, none but very elaborate, and, for the practitioner, almost impracticable processes, by which these examinations could be made, had been formulated. Examinations of the urine have been greatly simplified; and whether it is acid or alkaline; whether saccharine or albuminous; its specific gravity normal or otherwise; and also as to the character of the deposit itself; whether of uric acid or of lime, of magnesia or of ammonia; whether in combination with phosphoric or oxalic acid,—are all questions which the beautiful and exact science of urology has made simple and attainable to the busiest practitioner who may take the trouble to read the formulæ and provide himself with the few simple implements required for the easy process: but as we have said, the question of a history *anterior to this*, has seldom or never, we think, been the subject of analytic research.

The restricted scope and special object of this communication, forbid our devoting further space to the subject of “the water history of calculi,” a subject which we believe to be only incidentally connected with our discussion of the calculous diathesis. We would here, however, respectfully ask, to suggest the inauguration of a simple method of examination, with the view of testing the degree of hardness of the water used by patients *previous to the operation*, which, if constantly pursued, will place in the hands of the lithotomist this portion of the history of each case, the record of which has heretofore been generally so loosely and imperfectly made, or wholly neglected. It is again to a kindred department of medicine—sanitation, that we must look for assistance here in completing the history of calculous generation and growth. The importance of the subject of the constituents of drinking water, in answer to the benevolent claims of public health, has resulted in the establishment of a systematized method, simple and easy of manipulation, which if transferred to lithology, would, we think, supply the de-

fiency so constantly met in all records and reports of the history of calculus.

SOAP-TESTS FOR HARDNESS.

Water chemically pure, it is said, is not obtainable out of the laboratory of the chemist. Both organic and mineral impurities are found in solution in every specimen of water that has a natural origin. With the organic vitiations we are not concerned, nor any more with a very large number of the mineral impurities. Some two or three of these last, however, are almost invariably present in a greater or less degree. Those that more particularly concern our investigation, are the calcium and magnesium salts so often held in solution and to which are due, almost entirely, what is known under the name and quality of "hardness." These are sulphates, carbonates, chlorides, nitrates, and phosphates of the above metals, acquired during percolation through catchments in which they more or less abound.

To come directly to our tests; the term "hardness of water," as is well known, is derived from the common popular observation of the *soap-destroying property*, in a greater or less degree, of all water holding the above salts in solution. Based upon this known cause of hardness, Dr. Clark, of Aberdeen, Scotland, conceived a plan for measuring by a standard test the amount of mineral ingredients held in solution by any given specimen of water. It is to him, that we owe the ready facility with which this important question may now be determined by lithologists as well as by sanitarians. We are not aware, however, that either Dr. Clark or any one else has heretofore attempted to apply his test in determining the "water-history" of calculus. This use of his method, and for such an object, we believe was first made by us, and is here for the first time reported.

In order to give an idea of Clark's method, it will be sufficient to state, that to arrive at a *standard degree of hardness*, he dissolved with care, sixteen grains of Iceland spar (pure carbonate of lime) in a gallon of water, denominating this, as "water of sixteen degrees of hardness." Finding then the exact amount of a certain soap-solution (one ounce to the gallon of water) would by measure be destroyed by a proportionate amount of the standard calcareous water, he upon this plan establishes his method of testing the strength of the mineral solution—whether above or below "the standard sixteen degrees of hard-

ness," in any given specimen of water to which he might wish to apply his test. It is quantitative as to the combined amount of minerals in solution, but does not discriminate them qualitatively.

So important do we regard the object of rendering easily accessible to the profession the ready means of determining accurately the water history of every calculus offered hereafter for treatment, that we here introduce, without apology, Clark's method of preparing *The Standard Soap Solution*, and also *The Water of Standard Hardness*, as simplified by Mr. Sutton. Those used in our analyses were prepared for us by Mr. J. W. Pauknen, of this city:—

“Standard Soap Solution.—The following are Sutton's excellent directions for preparing this test: Put together in a mortar 150 parts common lead plaster (*emplastrum plumbi*) and 40 parts of dry carbonate potassium. When they are fairly mixed, add a little methylated spirit, and continue triturating until a uniform creamy mixture is obtained. Allow to stand for some hours, then throw on a filter, and wash several times with methylated spirit. The strong solution of soap thus obtained must be diluted with a mixture of one volume of distilled water and two of methylated spirit (considering the soap solution as spirit), until exactly 16 cc. are required to form a permanent lather with 50 cc. of water of standard hardness. The mode of conducting the operation is that described in the text; but we will suppose that the operator finds the solution too strong: suppose 50 cc. of standard water uses up only 14 instead of 16 cc. of soap solution, we dilute 1.400 cubic centimetres with 200 cc. of a mixture of two volumes of plain spirit and one of water—mix thoroughly together and again determine the strength so as to make certain that exactly 16 cc. are required for 50 cc. of standard water.”

“Water of Standard Hardness.—Place 2.29 grammes of pure colorless calc. spar in an evaporating dish of about one-quarter litre capacity. Pour over the mineral a little water, and add, drop by drop, pure strong hydrochloric acid. The calc. spar dissolves with effervescence, forming a solution of calcium chloride; the liquid is evaporated to dryness in a water bath. Water is then added, and the solution again evaporated to dryness. It is necessary to repeat this evaporation several times, in order to insure the removal of excess of hydrochloric acid. But these operations must be conducted so as to avoid the slightest loss. The residue is finally dissolved in distilled water, and the solution poured through a funnel into a litre flask; the capsule and funnel are then repeatedly rinsed with water, and the rinsing received in the flask. The liquid is

then made up to the bulk of a litre, and the whole well shaken and then poured into a dry stoppered bottle, and labeled 'Solution of 16° of hardness.'"¹

We have thus been led into the discussion of drinking-water by the rapid rate of precipitation characterizing several of our cases. A more unquestionable decision could have been made in regard to them had the water of the particular wells or springs, used during the period of accumulation after the introduction of the nuclei, been carefully tested. This indeed can be done at any time hereafter.²

It seems to us, and we respectfully suggest that it would be proper, that systematic works on urology and lithology should hereafter contain the formulæ necessary for the practical application of Clark's soap-test in establishing an *accurate water history of calculus*. For our present purpose, it is only necessary to refer to some of the works on public health in which they are contained.³

A Case of Multiple Calculi resulting from injury to the spine; calculus production continued during thirty-nine years, in a soft-water district. Repeated lithotomies: seven and a half ounces of calculi; each stone with uric acid nucleus.

CASE XL. Samuel O'Bannon, white, aged sixty years; residence, Barnwell District, South Carolina. This remarkable case, presenting what may be called "a perpetual quarry of phosphatic limestone," is not unfamiliar to the medical profession. The graphic pen of our revered and distinguished preceptor, the late Prof. Paul F. Eve, of Nashville, has furnished its history in a communication rich in wisdom and experience to this Association during its twenty-seventh annual meeting, held in San Francisco, May, 1871. The exigencies attendant upon the com-

¹ Op. cit. Appendix.

² As stated in a former note, the specimens of drinking water in each of these cases have been obtained since the above writing. The exact "degrees of hardness" cannot be stated, but in neither the water drunk by Griffiss nor that by Col. Crawley during the period of their stone formation was there more than a trace of calcareous solution.

³ The Manual of Public Health for Ireland. By Thomas W. Grimshaw, J. Emerson Reynolds, Robert O'B. Furlong, and John William Moore. Dublin, 1875, pp. 227. A Manual of Hygiene, Public and Private. By Charles A. Cameron, Ph.D., M.D., etc. etc., Medical Officer of Health for Dublin. Dublin, and London, 1874, pp. 76 *et seq.*

pendious tabulation of one hundred cases have resulted in a slight irregularity in Dr. Eve's recountal of Mr. O'Bannon's case; we, therefore, assisted by his synopsis, will attempt here to present the main facts and dates of the case consecutively:—

Operation 1. By Dr. Paul F. Eve, at Augusta, Georgia, January, 1849. Age of patient at that time, reported by Dr. Eve, forty-three years (according to our record, made on second operation, fifty years); residence, Barnwell District, S. C. Bilateral lithotomy at City Hospital in presence of class of Medical College of Georgia; multiple calculi, $117 = 4\frac{1}{2}$ ounces, chiefly phosphates: result, speedy recovery.

Operation 2. By H. F. Campbell, at Augusta, Georgia, July, 1859, somewhat over ten years after the remarkable operation of Dr. Eve. The patient reports that he has continued to live in Barnwell since first operation—we are certain that he reported himself to us at this time as being *sixty years of age*—he had the appearance of seventy. We think the age recorded by us was correct, and that consequently he must have been *fifty* at the time of Dr. Eve's first operation.

He stated that “he had been injured in the spine in 1824, when quite a boy,” about fifteen years of age according to our dates. After getting up, or perhaps while still confined, “he suffered very much with his water,” and soon began to pass “gravel-stones,” which often obstructed the passage of his urine. We recognized him as the man from whose perineum and bladder we had assisted Dr. Eve at the City Hospital, when he removed over a hundred calculi of limy constituents. Dr. Eve it appears had now requested him to come to us for operation, he having removed to Nashville. The stones removed by Dr. Eve varied in size from that of a split pea to a hickory-nut or almond. We are confident that at the time of his operation in 1849 the bladder had been entirely cleared of gravel and calculous fragments. He reported to us now, however, that “he had soon begun to pass gravels” after Dr. Eve's operation, but he said he was certain there were a great many in his bladder that had come there since Dr. Eve had cured him, and he felt confident some of them were too large to come away. There was scarcely any trace of the scar left by the first operation. On introduction of the sound, it was felt to pass through a bed of gravel which the instrument seemed to encounter before fully entering the bladder. An obscure grating could be felt in the perineum by pressure on the

skin and intervening tissues against the convexity of the sound. Though sixty years of age, and though extremely emaciated and worn down by irritative fever, we still felt it our duty to attempt the relief of this man by lithotomy. It was evident that he could not live unless some measure of relief was adopted.

Assisted by Drs. Robert Campbell, S. B. Simmons, and others, we performed the ordinary bilateral operation, the patient being first stimulated with whiskey and anæsthetized by chloroform. *Fifty-eight calculi*, exactly resembling in every particular those removed by Dr. Eve ten years before, were now removed. Two or three of them were fully the size of pigeon-eggs, and from this they diminished in proportion down to those of the smallest peas. These stones, we are confident, were not all in the bladder, but some of them appeared to be in a sac in the region of the prostate gland, which sac seemed to communicate with the cavity of the bladder by a small opening. We think a full report by Dr. Eve of his first operation would reveal a similar state of things at that time. We did not have them tested, but decided that they belonged to the "triple phosphate" variety, perhaps with phosphate of lime. Dr. Eve has noted those removed by him as "phosphate of lime." We observe that they all have a varnished appearance, and that some appear beautifully glazed. This glazing, Chelius says, is "a layer of urate of ammonia." As reported by Dr. Eve in regard to this operation, performed by us for him, "he made a good recovery." He recovered very slowly, but entirely, from the operation, and returned to his home in Barnwell. Some year or two after we had heard of his being still alive, but we were only made aware of his having submitted to the operation a third time on reading the published analysis of Dr. Eve's cases above mentioned.

Operation 3. By Dr. Paul F. Eve, Atlanta, Georgia, April, 1863, nearly four years from our own operation, the second—fourteen years from Dr. Eve's, the first—and thirty-nine years from the date of the spinal injury in 1824, which dated the beginning of calculous elimination—may we not say *secretion*? The operation was again bilateral lithotomy. Eighteen calculi, similar to those removed in the two previous operations, were now removed. Dr. Eve again records them as composed of "phosphate of lime: result, "death." "He did well," writes Dr. Eve, "until the twelfth day, when he was attacked with erysipelas of the hand and forearm, and died; the wound had nearly healed." He was now at least sixty-four years of age.

In all, the number of calculi removed in the three operations besides those passed spontaneously, of which the number cannot be estimated, was one hundred and ninety-three. Lithogeny probably continued uninterruptedly during a period of thirty-nine years—that is, from the time of the spinal injury in 1824 to the time of his death in 1863.¹

Were we presenting O'Bannon's case as a *curiosity*, its value as such would be greatly diminished by reference to systematic works. Multiple calculi, though not by any means so common as single or double or triple ones, are by no means unprecedented in lithology. Dr. Gross, up to 1855, had but one case, a gentleman of Kentucky, aged seventy-six years—fifty-four calculi; in the bladder of the naturalist, Buffon, were found fifty-five; Sir Astley Cooper had one case of a hundred and forty-two; Dessault, one of over two hundred; Kruger, Dupuytren, and others, had similar cases; Dr. John Kelly, of New York State, removed two hundred and twenty-eight; Tulpius, Boerhaave, Beauchene, and Ribes each record a case of upwards of three hundred. "In the case mentioned by Ribes," says Dr. Gross,² "three hundred were found in the bladder of a man after death *who had undergone lithotomy three times*," in this particular being similar to the one under consideration. Murat met with six hundred and seventy-eight; Schurig, seven hundred; the most extraordinary example on record being the case of Chief Justice Marshall, operated on by Dr. Physick, where upwards of one thousand calculi, "from the size of a partridge-shot to that of a bean, were removed."

The above cases are indeed very marvellous, but the antecedents not being accessible, they do not equal in *value to us* that of O'Bannon and some others to be mentioned, so far as our particular line of study is concerned. Our own other case of multiple calculi—Case XXIX.—is also of no value to us, as we have neither record nor recollection of its concomitants. The five calculi are of similar appearance to those removed from O'Bannon.

Our friend Dr. John S. Coleman, of this city, during the winter of 1875-6, consulted us in a case in which after relieving an *almost impervious stricture*, which had long been a source of irri-

¹ We regret that our most strenuous efforts have failed to procure the drinking-water in O'Bannon's case. Nobody can identify him by "name or local habitation."—O'Bannon was *poor*.

² Op. citat, p 445.

tation and distress, he discovered the patient, a white man, aged thirty-six years, to be the subject of one or more vesical calculi. Bilateral lithotomy was performed in presence of the medical class and three white varnished looking calculi readily removed; they were about the size of filberts. Exploring instruments through the urethra still producing a grating, the bladder was deluged with cold water, but the object was not removed. After some search two other similar calculi were discovered and removed from a pouch just below the neck of the bladder, which pouch was found, as in our case, to communicate with the cavity of the bladder.

This man, so far as we could ascertain, had suffered no spinal injury. Could the long-existing irritation of the severe stricture have excited the generation (secretion?) of nuclei by reflex influence upon the bladder and kidney? That the irritation consequent upon injuries and diseases of the penis, as well as diseases of the spine, have been apparently etiologically connected with the generation of calculi within the urinary passages, there can be no doubt. Dr. J. F. South, the English translator of Chelius's Surgery, relates several cases illustrative of this kind of action. A young man, twenty-three years of age, was under the care of Dr. Vincent in St. Bartholomew's Hospital. He had received upon the penis the kick of a horse, from which, suffering incontinence of urine, he wore a yoke to prevent the flow. A swelling was found behind the scrotum at the time of his admission. This had attained the size of a goose-egg. When opened, it gave exit to one hundred and forty-six calculi, of various figures and sizes, the largest being about the size of a horse bean. The sac communicated through the urethra with the bladder. The stones consisted of "the fusible compound (phosphate of lime and of ammonia and magnesia) formed upon indistinct nuclei of urate of ammonia."

Vincent had another case of numerous calculi, which, with about two hundred others, were removed from between the prepuce and glans penis of a very old man. *The patient had congenital phimosis*—a source of great irritation—the orifice of the urethra (prepuce?) scarcely admitting the introduction of a common probe. From the presence of the calculi, the prepuce was distended to the size of a pullet's egg, and retention of urine was finally produced. This patient had during many years experienced great pain and difficulty in making water. The calculi

were composed of the phosphate of ammonia and magnesia, with phosphate of lime—"fusible compound." "For the composition of the nucleus," says the college record, "there can be no doubt that the greater number of those calculi had passed from the urethra into the sac of the prepuce, and their irregular form and close adaptation to each other, proves that in this situation they had increased considerably in size by the deposition of earthy phosphates."

The similarity of these cases in the size, shape, and constitution of the calculi to those removed from O'Bannon's bladder and perineum, the generation of which were seemingly the result of *perverted nervous action, consequent upon the spinal injury*, there being no obstructive stricture or phymosis, is very remarkable. There can be no doubt that in all these cases above quoted, from some cause or other, the lithic or uric acid diathesis had been established, initiating the generation of numberless idio-genic uric acid nuclei which, but for the existence of the obstruction, would probably never have resulted in stone at all, but have passed away, undetected,¹ with the daily passing of urine.

The following case, our most recent lithotomy, is here appended, as the operation was performed since the reading of this paper.

CASE XLI. A. McF., of Port Royal, S. C., aged 28 years. In 1872, found his urethra obstructed, and the urine dribbling away. He applied to Dr. Stewart, of Beaufort, S. C., who, by use of a catheter, relieved the greatly distended bladder. He used the catheter for two months, when the symptoms of "stricture" subsided for three years. During another attack of urethritis, August, 1878, he was suddenly seized with vesical distress and retention, and again had to use the catheter. He was now treated in Charleston, S. C., for stricture—by internal urethrotomy. On his return to Port Royal, finding the symptoms unrelieved, he came to Augusta for treatment.

Examination, Feb. 10th, 1879. Stone of considerable size detected near the neck of the bladder by the sound.

¹ In the published cases heretofore mentioned in this paper, Dr. L. A. Dugas reports that of "a man of fifty, who had suffered many years with gravel which he continually passes. He has a collection of over twelve hundred, passed in a few years. They are round, and resemble a collection of shot of all sizes."

May 16th. McF. returned for operation at this time, but on account of his impaired health, he remained under tonic treatment till the 10th of June.

Operation, June 10th, 1879. Assisted by Drs. John S. Coleman, Edward Geddings, A. Sibley Campbell, and other medical gentlemen, we performed ordinary bilateral lithotomy, the patient being "under ether."

Nothing unusual occurred during the operation. The stone presents a fine specimen of alternating limy and uric acid strata deposited upon an oblong uric acid nucleus. Long diameter, $2\frac{1}{8}$ inches; short diameter, $\frac{7}{8}$ of an inch.

Hemorrhage.—In this operation, the lithotome was set for a moderate incision. The bleeding, though not profuse, continued during the afternoon. At night, considerable clots began to pass from the bladder through the wound, while fluid blood came through the penis. With the valuable assistance of our friend, Dr. J. S. Coleman, the bladder was emptied of a mass of clots, and washed out with tepid, then hot and then cold water. It being now plain that packing was necessary, we applied the *tampon en chemise*, with pledgets of absorbent cotton saturated in tannic acid. The tampon tube being without grooves, rendered the packing difficult and uncertain. The flow was finally arrested, and the urine ran clear from the tube. The tampon was kept in fifty-five hours, till signs of suppuration in the wound were observed. This length of time was probably unnecessary. There was no indication of hemorrhage after removal of the tampon. Though the urine came from the wound, the patient *had control*, and passed it at intervals "with desire."

Notwithstanding the long interruption of over two days by the tampon, the perineal wound healed with remarkable rapidity. Urine soon began to pass through the penis, and McF. returned home well on the 25th of June—fifteen days after the operation.

Water History of the Calculus.—At our request, Mr. McF., on his return for operation, brought from home specimens of the drinking water he had used during his residence at Port Royal—a period of over seven years—(his first symptoms of vesical trouble began in 1872). These specimens were not subjected to Clark's test, as at that time we had no means of "standardizing" our soap solution. The preliminary process with solution of ammonium oxalate showed only the very faintest cloudiness,

there being no perceptible precipitate, even after standing for hours. The lime entering into the composition of this large stone was certainly not derived from the water drunk by the patient at Port Royal.

Remarks.—In the above, as in the several other cases of hemorrhage reported in the foregoing paper, we think the *Bulbar Artery* was the one which was cut, and which yielded the alarming amount of blood. Wounds of this vessel, many years of observation have impressed us, are quite serious, and fully capable of bleeding the patient to death if not promptly and efficiently dealt with. Fortunately they are, we may say, always controllable by pressure. We believe that the grooved *tampon en chemise* offers the most convenient and reliable means of applying this pressure.

Give QUININE till the wound is healed.—In the after treatment of the foregoing case, as in that of every other, *quinine* was given to the extent of ten or fifteen grains a day. This *rule*, which we cannot now argue, we never depart from. Over thirty years of experience has irrevocably fixed our convictions as to its inestimable value.

In concluding our remarks upon this last series of cases, illustrating the persistent and abundant genesis of calculous matter, we call attention particularly to the fact, that in each one of them except the last, there had existed, either some injury of the spinal centre, as in O'Bannon's case, or some cause of *constant peripheral irritation* at the penis, as stricture, phimosis, etc., for the entire period during which the genesis of uric acid nuclei¹ had been continued. With this pertinent remark, we ask for the present to defer the discussion of these significant cases, *till we can examine*

¹ There is no question as to the vastly greater frequency of *uric acid*, as forming idiogenic nuclei, as compared with all the other forms put together. "If we take into account," says G. Owen Rees, "all the calculi of which the lithic acid or its compounds form the nucleus, the proportion of calculi originating with this principle (and which probably would otherwise not have been formed), is very much greater." He then examines carefully the proportions of uric acid nuclei as found in the specimens in various hospitals; Bartholomew's, Guy's, Norwich, Manchester, Bristol; the hospitals in Suabia and in Copenhagen. And he finally remarks: "The relative proportion of all the calculi originating in some form or combination of lithic acid, in all the different collections, is nearly as 1 : 1½, which is equal to saying that, if a lithic acid nucleus had not been formed and detained in the bladder, two persons at least out of three who now suffer from calculus, would have never been troubled with that affection."—*Cyclopædia Anatomy and Physiology*, Article "Urine."

them in connection with others, constituting a large class, which we think can be made, even still more clearly to illustrate the reflex excito-secretory or "excito-vasomotor" pathogeny of such idiogenic nuclei.

LITHOTOMY IN THE FEMALE—VAGINO-VESICAL INCISION—REMOVAL BY DILATATION.

It is by no means difficult for the experienced practitioner to accept the causes assigned in systematic works for the remarkable difference in the frequency of calculus in the male and female. Like all other diseases—common, but in a different degree, to the two sexes—the greatly less exposed condition of the female to the general causes which are supposed to favor the occurrence of renal and vesical derangements, would go far to account for the comparative immunity of the female from the origination of nuclei in her urinary passages and cavities. However this may be, there are conditions universally recognized as pertaining to the female which are undoubtedly, beyond all comparison, the cause of the almost entire freedom of the sex from the distresses of vesical calculus—the shortness, dilatability, and directness of the urethra, together with, perhaps, the chances of flushing out the stone in the greater and more frequent distension of the bladder, incident to greater pelvic amplitude.

Many circumstances seem to indicate that while detention of the nucleus is the indispensable condition of vesical calculus, this detention is, even in the male subject, not the invariable, or perhaps the most common result attending the formation of small concretions in the bladder or kidney. It is probable that there are comparatively but few, even in the male, that are detained and become too large for exit by the urethra. How invariable is the expectation, and how seldom is there disappointment, in finding "the gravel pass out" after attacks of "nephritic colic." The case quoted from Vincent plainly indicates that while the irritation caused by the phimosis was most probably the excitor influence, initiating the disturbance of renal secretory action, which induced the genesis of uric acid nuclei, the closeness of the orifice of the sac was the sole cause of their detention, and of the accretion upon them to form the preputial calculi. In the same way the injury of the young boy's penis by the kick of the horse, giving rise to paralysis of the vesical sphincter, and probably modifying renal secretory action, would not have

resulted in the vast accumulation of calculi in the urethra, but for the retentive yoke which he wore to prevent incontinence. But for such obstructions, these vast numbers of calculi would never have been found, or perhaps never known to exist, their nuclei having passed out unobserved. For these reasons, it is not surprising that the occasions are so rare, both actually and comparatively, in which the lithotomist has to record operations on the female. The vast majority of these nuclei, especially in the female, escape by the urethra very soon after entering or forming in the bladder. But in women, even after attaining considerable size, they often yet find exit, and escape being the subject of operation. This is the case, almost invariably we think, with idiogenic nuclei, but the records of lithotomy are crowded with cases which constitute the curiosities of its literature, and which are illustrative of the fact that foreign bodies large enough, or of such shape as to secure retention, invariably become incrustated with equal, if not with greater, rapidity in the female than in the male, *by the modification of secretory action which they excite*, and by the rapid precipitation to which they give rise. Vide the hairpins, bodkins, needle-cases, catheters, slate pencils, *et id omne genus*, which will be found enumerated among the xenogenic nuclei that have been found from time to time initiating calculi in the female bladder. Among our own operations, out of what we believe to be over fifty in all, we find the record of but four lithotomies upon the female subject. The following is illustrative of the tendency of calculi, of even considerable size, to escape from the female bladder.

Case XLII. Mrs. W. S. N., aged about 30 years, a resident from birth, of Burke County, Georgia, had been the subject of vesical irritation for a year or two. Her symptoms were reasonably attributed to uterine displacement and was considered as one of the attendants of hysterical excitability incident to uterine derangement. She had undergone much of the routine of measures considered warrantable in such conditions, had visited springs and resorts supposed to be beneficial in such states of health, and was finally recommended to the care of Dr. J. A. Eve of this city for the treatment of a "tumor" just within the pubic wall of the pelvis and which could be felt above the vulvar end of the vagina through its anterior coats. To the tumor various applications had been made; among them leeches had been applied several times to lessen the tenderness

and turgescence and to prevent suppuration, which at times was supposed to be impending. Finding the case entirely surgical in its nature, Dr. Eve advised that we should visit her, requesting that we make special investigation of the bladder and urethra. On inquiry we found that she had, some months ago, suffered for a time much more than her usual amount of vesical irritation. Then, at times, there was obstruction to the passage of the urine; this was quite serious for a considerable time, but never amounting to complete retention. The obstruction gradually became less and less till finally it disappeared leaving only burning in micturition and tenderness in the situation of the tumor. She had been catheterized but no stone had been detected, we do not think one had been suspected. Finding a hard resisting tumor behind the clitoris, and above the upper wall of the vagina, which, on account of considerable tenderness, was somewhat intolerant of pressure, we, not suspecting calculus, introduced a silver catheter to aid in the exploration from the bladder-side of the tumor. We had almost completed our inconclusive investigation when on pressing the tumor against the catheter, we perceived a decided grating as the instrument was withdrawn. Further examination developed the presence of a calculus. This had been arrested in the vesical end of the urethra or neck of the bladder and *pocketed* there by a dilatation of the lower wall of the canal. Being satisfied of these conditions we appointed the following day for the operation.

July 21, 1857. This lithotomy was of the simplest character. The stone must have been pocketed mostly in the urethra and partly beyond the sphincter of the bladder. The incision was therefore vagino-urethral rather than vagino-vesical. The patient having been anæsthetized by chloroform, assisted by Dr. Eve, a common grooved director was carried into the urethra with the view of making prominent the line to be incised. Finding that it did not pass easily between the stone and the urethro-vaginal wall we laid it aside and seizing the tumor between the thumb and forefinger of the left hand, a cut of nearly an inch was made directly upon the stone in the median line. The grooved director was used to somewhat loosen the calculus in its bed, and it was very readily withdrawn through the vagino-urethral incision. No sutures were required, there was little or no incontinence of urine and the wound rapidly closed, over a catheter worn for a few days, apparently by the first in-

tention. The lady returned home well within ten days. The calculus was of a dark brown color, was not tested but was probably of uric acid. It weighed about two drachms, rather light for its size, which was that of a small marble. Burke County was at that time a region strongly characterized by malarious diseases, and it is said here and there to contain calcareous solutions in the drinking-water of certain neighborhoods. We have no water-history of this particular case.

Before describing our next case of lithotomy we give the particulars of a case treated by rapid dilatation and extraction within the past two weeks while engaged on the present report. Our last case is *simply curious*, having no bearing whatever upon our course of pathologic investigation.

Removal of a Quartz Pebble by rapid dilatation. No calculous deposit remaining three years after in the bladder.

CASE XLIII. Maria Tilman, a colored woman, aged about 40 years, a resident of Augusta for the last two years, had suffered from vesical irritation for over three years, had been treated by several physicians of Augusta. We had not seen her until she was referred to us for operation by Dr. M. A. Cleckley of this city, who on examination with a sound had discovered a stone in her bladder.

We found her bladder extremely irritable, the vulva and urethra tumid and tender. She had not been able to urinate for some months without the use of a gum elastic catheter which she had learned to use herself. On introduction of the sound we at once detected the calculus, which on being struck gave out what appeared to be a peculiarly sharp ringing sound. Finding it of small size, we determined to attempt its removal by rapid dilatation.

August 18, 1876. Being sent for in haste, we found the stone, though not in the neck of the bladder, quite accessible. Assisted by Dr. A. S. Campbell, we rapidly dilated the urethra, first with a No. 12 steel bougie, then gradually up to No. 17, when by means of a dilator we were soon able to enter the index finger of the left hand to the second joint. We now introduced without trouble the smaller calculus-forceps of our lithotomy case and very readily succeeded in seizing and extracting the object, which to our surprise we found to be a quartz pebble of rather oblong proportions and an irregular cuboid in shape. It had no

deposit whatever upon it and was as clean and natural in appearance as though it had just been taken out of a stream. Being urged for an explanation the woman assures us "*it was pushed into the bladder at least three years ago, and that she has not had a moment's peace since.*" It weighs sixty-eight grains.

28th. Maria still suffers from vesical irritation, though she does not have the same amount of tenesmus and "straining" as before the removal of the pebble. There is still some incontinence of urine, but she is gradually improving in this respect.

We had seized this stone with Herteloup's *brise pierre*, but for a very good reason, as has been seen, failed to crush it. The inexplicable peculiarity of the above case is, *the entire absence of deposit* on a nucleus that had remained in the bladder over three years. This is an occurrence without precedent in our experience. Can it be possible that foreign bodies of *certain materials*, silix or quartz being one of them, do not admit of calcareous precipitation upon their surface so as to constitute them the nuclei of stone? A case reported to us by a distinguished member¹ of the International Medical Congress, in which a portion of the glass tube of a thermometer failed after years' residence in the bladder to collect calcareous strata would indicate that highly polished mineral surfaces resist precipitation. We know of no way of testing the question in regard to quartz otherwise than by actual experiment or by observations rarely afforded on cases as they occur.

Removal of a small Uric Acid Calculus, by gradual dilatation, from an infant of twenty months.

The following case is among those which occurred since the numbering of our list, and adds another to the class of infant cases dating from the period of first dentition.

CASE XLIV. S. F., residence Augusta, Georgia, aged 20 months. At 15 months of age, in first dentition, the child manifested symptoms of vesical tenesmus and great irritation. No examination made, and treatment interrupted by removal to Memphis, Tennessee. Dr. D. D. Sanders, coming in charge of the case, verified the existence of calculus by the sound, and on the patient's return to Augusta referred the case to me for treatment.

Gradual dilatation by gum elastic and steel bougies was per-

¹ Dr. J. W. S. Gouley, of New York.

severed in for nearly two months. The dilatation attained being No. 18, English scale, of steel sound. The vesical irritation was unabated up to this time, but suddenly and permanently ceased on the passage one day, of a "hard dark object like a piece of bone," as reported by the nurse. This was probably a small calculus of uric acid. It was unfortunately not preserved to be inspected and tested by us. Even with the prolonged use of the large sounds, there was no failure at any time in retention of urine. The child though somewhat emaciated from irritation, became and remained perfectly comfortable from the day of the discharge of the calculus and rapidly recovered her flesh and good spirits.

Vesical Calculus in connection with Vesico-vaginal Fistula. The Calculus antedates the Fistula.

The following case illustrates the ready facility with which lithotomy vagino-vesical incisions unite as compared with the denuded edges of ordinary vesico-vaginal fistula.

CASE XLV. Mrs. R., aged about 26 years, had previously been operated on by us for vesico-vaginal fistula. Before the discharge of the patient she was found to be the subject of a calculus which had escaped detection at the time of the operation and in the previous examinations, on account probably of being pocketed in the upper portion of the bladder.

A sound was passed into the bladder through the urethra, and the vesico-vaginal septum was held steady by a tenaculum penetrating into the bladder. A short incision was made upon the end of the sound through which it protruded into the vagina. With the curved sound held in this opening, we divided the vesico-vaginal septum backwards in the median line for more than an inch, with a curved bistoury crossing the line of the cicatrix left by my operation for vesico-vaginal fistula. A stone as large as an English walnut was readily removed through this opening by the forceps. Phosphate of lime externally with uric acid nucleus.

Although Dr. Emmet, whose operation was used in the above case, regards sutures as unnecessary, nine or ten silver sutures were applied in the present instance, and the case was in its after-treatment managed as an ordinary vesico-vaginal fistula. After the removal of the sutures, in some eight or ten days, the case required but little or no attention, and Mrs. R. returned

home well, and has had no trouble with either stone or fistula since.

Mrs. R. was an extremely delicate and diminutive woman, had suffered from childhood with trouble about her bladder, and had contracted the habit of morphine-eating. As the above case was published in the first volume of *Gynecological Transactions*,¹ we refer the reader to its fuller report in that place.

This stone was evidently in the bladder, and not detected at the time of the plastic operation: and this we believe to be the history of all calculi in such connection.

As we have written,² "such calculi do not always result, as thought by Dr. Emmet, from the closure of the fistula, but more often exist in the bladder, though not detected, at the time of the operation. They probably antedate the fistula and are instrumental in its production during the labor."

"The two practical deductions from the above interpretation of my case of vesical calculus found after fistula, are the following:—First, that careful examinations should be made for stone *previous to the closure of the fistula* in all cases in which the known circumstances attending the occurrence of the accident do not exclude the possibility of its presence in the bladder; and secondly, that all patients should, previous to discharge, be subjected to careful sounding *after the cure of the fistula*, and to distension of the bladder by urine or by the injection of water."

Vagino-vesical lithotomy—Blood-clot nucleus—Silver sutures—Recovery without fistula.

CASE XLVI. C. N., a bright mulatto woman, aged about twenty-five years, a resident of Edgefield County, South Carolina, was brought to our attention, by our friend, Dr. J. Walter Hill, of Edgefield, during a visit to that place in behalf of another patient. Our history of the case previous to the day of operation is imperfect. She had, however, suffered long from vesical irritation. Dr. Hill had been induced to explore the bladder, and with the sound detected the existence of calculus. Being kindly requested by the doctor to operate, with his assistance we performed vagino-vesical lithotomy as previously de-

¹ Origin and History of Calculi found in the Bladder after the cure of Vesico-Vaginal Fistula by Operation, p. 354.

² Loc. cit.

scribed. The incision was nearly an inch and a half. Entering the cavity of the bladder a considerable stone was grasped by the forceps which, with very little pressure, immediately crushed it into many fragments. The bladder being thoroughly cleared and afterwards deluged with water from a Mattson's syringe, we carefully closed the incision with silver sutures after the manner of Sims's operation. We think twelve or thirteen sutures were applied.

On examination of the larger fragments they were found to constitute integral portions of a hollow sphere. The interior of a portion of this sphere was indelibly stained and blackened, covered as it appeared to us with remains of blood-clot. The microscope has not been applied. From another portion of the wall of the cavity the stain was easily washed away, the surface here being convex, fitting probably against a corresponding concavity with an intervening cleft. We think that no one inspecting the fragments still in our collection, can doubt the correctness of the opinion that the calculous precipitation took place *upon a clot of blood* that had been detained in the bladder.¹ The blood seems to have afterwards dissolved leaving what appeared to be an empty but rather irregular cavity. The concretion is evidently a composite one, being partly uric acid and partly a limy phosphate. The pieces recovered weighed somewhat less than half an ounce. The stone was not tested. In the note below will be found a few references to blood-clot nuclei. Sigmoid catheters were advised in the after treatment. After the removal of the sutures at the usual time, by Dr. Hill, he found

¹ "Blood or sloughs may also form the nuclei of stone. This is, indeed, doubted by *Von Walther*, but there are stones which have cavities within them; and it is probable that the mucus of the bladder, or a similar albuminous animal substance, had at an early period filled it, and in the course of several years, had dried up. *Lisfranc* found in a urinary stone as big as the fist, a blackish nucleus of slight consistence which resembled a clot of blood, and on chemical examination, presented a fibrinous substance. *Cruveilhier* showed in the Anatomical Society at Paris a very large urinary stone, of which the nucleus was a clot of blood. *Sir Astley Cooper* (*Surgical Lectures*, Vol. II. p. 242) mentions a case in which having removed a triple phosphate stone, the disease returned, and he again performed the operation, and found a *large coagulum of blood* in the bladder, surrounded by a triple phosphate deposit."—*South's Chelius*, Vol. III. pp. 248-49. "In the College Museum," says Dr. South, "there is a stone consisting of uric acid deposited upon a hollow crust or shell of impure oxalate of lime. This crust was most probably *formed upon a clot of blood*, which has afterwards shrunk."—*Op. cit.* p. 250.

there were minute fistulæ between several of the sutures. A second communication, however, informed us that they had closed, and that his patient was perfectly well.

Though the above case has furnished the only clot-nucleus in our collection of specimens, we have shown by reference to other writers, that such cases are by no means without precedent. Persulphate of iron, should it be injected into the cavity of the bladder for vesical hemorrhage, would, from the firm and putty-like clot it produces, almost certainly furnish a blood-clot nucleus for a subsequent stone.

A large vesical calculus, dating probably from infancy, in a young woman affected with ankylosis of the lower jaw, resulting from cancrum oris in infancy—Its almost spontaneous expulsion in articulo mortis—Buccal irritation the probable source of its production.

CASE XLVII. Miss M. R., a young lady, aged about seventeen years, was a native of Barnwell District, South Carolina, but from the age perhaps of ten, had resided in Augusta. She was extremely thin, cadaverous looking, and badly developed. Had been afflicted from infancy with ankylosis of the lower jaw and distortion of the mouth with adhesions and loss of substance about the cheek, consequent upon cancrum oris. This condition had been attributed to the injudicious use of mercury in the treatment of autumnal fever. Of this, the truth is quite uncertain. Over forty years ago, quinine, even among the progressive practitioners of the South, had not become the recognized method for remittent forms of fever. Calomel was largely used as a febrifuge. Mercurial salivation may possibly have produced the deformity and disability in question. This young lady was the subject of constant irritation about the mouth—the flow of saliva was often abundant, and her unhappy appearance rendered her a constantly appealing object of pity and sympathy.

At the time of our observation of the above case, our valued friend and colleague, Dr. Lewis D. Ford, of this city, was the family physician of her friends and had been consulted by them, on the subject of certain well-marked symptoms of vesical distress which, when brought to his attention, he at once recognized as the rational symptoms of calculus. The case had been kindly referred to us by him for early examination. This had

been injudiciously deferred by the parents on account of the opposition of the young lady. About this time, we were suddenly called to visit her in what was thought to be a convulsion. Dr. Ford arriving at the same moment, it was suggested to our minds that possibly some condition in connection with the supposed calculus might have caused the attack. In her unconscious condition this important examination was quickly made. To the astonishment of both of us, a stone of very considerable size—found afterwards to weigh over an ounce—was found half-way emerged from the orifice of the urethra distending this canal enormously and pressing down like a great ball, entirely occluding the entrance of the vagina.

An incision was rapidly made through the vaginal and urethral coats and the stone extracted. Efforts were diligently made to resuscitate her, but both pulse and respiration had ceased. The supposed convulsion must have been her death-struggle under the stress and shock of passing so large a calculus in her extremely low condition. The stone consisted of alternations of uric acid and phosphate of lime.

The above case will be again referred to in connection with buccal irritation as modifying the secretory action of the liver and other organs in the production of uric acid to be excreted by the kidney, forming first the nucleus and then the successive superjacent strata which alternated with the limy layers.

PART II.

ETIOLOGY AND PATHOLOGY.

The Neuro-Dynamic Origin of Calculus—Morbid Excito-Secretory Action, the True Origin of the Calculous Diathesis—The Relations of the First and Second Periods of Dentition to the Origination of Calculus—The Relations of Malarial Fever to Idiogenic Nuclei—Malarial Glucosuria—Malarial Lithæmia.

THE foregoing summary, and more or less careful elaboration of nearly fifty cases of calculus, have, we earnestly hope, occasionally served to illustrate various and, sometimes, important principles bearing upon some of the more common and general

questions of lithology. With the view of adding our testimony to the vast amount already accumulated, we have endeavored, as far as we were able, to give full prominence and distinctness to everything affecting unsettled questions which our records might contain. We have in no case attempted presumptuously to decide any of these, but have endeavored simply to supply the data for induction and analysis by others—possibly in the present but more probably in some future time. Notwithstanding we have been all along deeply impressed with the high importance of every relation bearing upon our subject, still, from our own mind, one principal object of an interest superior to all others has never for a moment been absent; and, throughout the long and tedious pursuit the attainment of one desired end has urged on and encouraged us to the present moment. This object of deep interest to us has been THE ETIOLOGY OF CALCULUS, and the end we have hoped ultimately to attain, is some clear and acceptable, even though not entirely conclusive, result as to the Pathology, or, to speak more correctly, the *Physiology of the Calculous Diathesis*. This result, failing us elsewhere, as it has all others, we hope now, by a careful consideration of our data, to find it, at least in part, in *The Nervous System*. We shall, at all events, consider its relations thereto.

At a period long anterior to the present, when the rather vague and indefinite doctrines of "Sympathy" supplied our clearest explanation of the now common and familiar phenomena of Reflex Action, the frequently observed influence of either near or distant irritations or impressions over the urinary secretion, was constantly recognized and made the basis of many practical—and indeed, virtually truthful—inductions in both Physiology and Pathology. The abundant and limpid urine of hysteria was then, as now, the recognized result of uterine irritation; the frequent and profuse micturition under exposure of the body to cold, was also classed among sympathetic phenomena, while the exhilaration of joy, or the depression of grief or of fear, and even the impressions upon some, produced by music and by sound, as influencing "the holding of the water,"¹ owed the satisfactory rationale given them, to principles which during all that time constituted the ultimate bounds of our knowledge in regard to that large and comprehensive class

¹ SHAKESPEARE—"And others, when the bagpipe sings i' the nose, cannot contain their urine."

of phenomena we now associate together, as those resulting from excito-secretory or excito-“vaso-motor” action of the nervous system.

Derangements of the nervous system, whether central or peripheral, have for a considerable period been distinctly recognized as giving rise to modifications in the quantity of the urinary secretion and the manner of its discharge. Sir Benjamin Brodie¹ mentions various forms of irritable bladder; and among them the case of “an elderly gentleman who complained of frequent attacks of giddiness. This symptom probably arose from altered structure of the arteries of the brain, causing an imperfect state of the cerebral circulation. Not unfrequently this is attended with an irritable state of the bladder, and though the urine is of a healthy quality and the bladder free from disease, the patient is tormented with constant micturition, voiding his urine without pain, but at short intervals, and in small quantity at a time.” He further remarks in regard to this subject: “Irritability of the bladder is sometimes the result of mere nervousness; of the same state of the bladder which in some individuals occasions a constant winking of the eyes or twitching of the muscles of other parts.” [Chorea?]

That states of actual disease in the central organs of the nervous system have been known, for a long time, to modify, not only the mode of discharge and quantity of the urinary flow, but also, most unquestionably, its *quality* in a marked degree, we find abundant evidence in works of the best authors. Dr. Prout,² in speaking of the “mixed phosphates,” makes this remark: “Among *acquired predispositions* may be mentioned enfeebled conditions of the nervous system, and more especially, the spinal nerves, from a variety of causes.” “Thus injuries of the back,” says he, “by concussions, blows, or other accidents, are exceedingly liable to bring on depositions of phosphates in the urine. Causes of this kind may vary indefinitely; but perhaps one of the most frequent, is a fall from a horse by which the individual has received, in connection with a general violent concussion of the spine, some local injury of the back. It is, I believe,” continues he, “an old observation, that certain injuries of the back are often accompanied by alkaline urine, and Sir Benjamin Brodie informs us that he noticed the circumstance

¹ On Diseases of the Urinary Organs. Third edition, p. 95.

² Stomach and Renal Diseases. 1843, p. 225.

as early as 1807.” We would refer here to the case of one of our own patients: O'Bannon—Case XL.—lithotomized twice by Dr. Eve and once by ourself, and *continuing the elimination of mixed phosphates for thirty-nine years*, as a remarkable instance of *altered centric cerebro-spinal action* over the vaso-secretory action of the kidney.

ector We have thus, without any extended research, been able to present sufficient evidence that the influence of the *central* nervous system, both in its healthy and diseased conditions, has long been recognized as a ~~feature~~ *feature* materially modifying the secretion of the urine, as to both its quantity and elements. A number of cases could be presented¹ to illustrate the fact also,—though no such influence has been heretofore attributed to it by others—that some of the most remarkable collections of phosphatic and triple-phosphatic multiple calculi were accumulated under circumstances in which *reflected irritation* from the urethra or from the prepuce might reasonably, under our present method of interpretation, have been predicated as the rationale of the phosphatic elimination which gave rise to these collections. Dr. Prout, whose observation is always accurate, remarks, that “the most frequent exciting causes of such deposits are *local irritations* affecting for a considerable time the bladder or urethra; or, for example, any foreign substance introduced into, and producing an excitement in, that organ, including, as we have before mentioned, all sorts of calculi; in certain circumstances, the retention of a bougie or catheter in the urethra, strictures of the urethra in particular constitutions; all of which, and many similar causes, are capable of producing *in all individuals*¹ a condition of urine readily depositing the phosphates.” “The fact is,” says he, in a note, “that the foreign substance before it is or can be covered with phosphates, *sympathetically affects the system*² and *causes* the urine to abound in these salts.”

Mr. Murray Forbes, quoted on this subject, says: “In proper or healthy urine there is not, in clean vessels, a particle of the phosphates deposited—the whole of these being in perfect solution, and to the end of time, there would not be calculus from renewed applications of urine in which the phosphates do not predominate. When a foreign body gets into the bladder, if it meets not with phosphates already redundant it would operate

¹ See cases presented in remarks upon that of O'Bannon.

² The italics are ours.

by irritation, so as to *occasion*¹ redundancy. The diseases which require catheters and bougies are almost uniformly accompanied by the prevalence of phosphates *from the general and particular sympathies*² by which they are attended."

Thus have we found it advantageous, in order to corroborate the views we wish herein to present, to collect from the records of lithology a number of scattered facts illustrative of some of our own cases, which, while they have been heretofore more or less particularly mentioned by others as remarkable events in the history of some few cases of stone, have never been particularly dwelt upon, either in the relations of etiology or of pathology, except as explained by the mystical doctrines of *sympathy*.

Were such an exercise as useful as it would be pleasing, we could collect from the recorded reflections of observing writers an abundance of testimony to indicate their recognition of the instrumentality of "sympathetic agency"—as the unrecognized reflex action was then called—in favoring the infusion of alkaline elements into the urine and their deposit upon any nu-

¹ The italics are ours.

² To understand the exact value of the term "sympathy," as held at this time, we quote the following:—

"*Sympathy*. Owing to an impression made upon one organ, distant organs become affected without our being able to refer the transmission to mechanical agency, or to the association of functions. This kind of association is called *sympathy*. A particle of snuff, or other irritant, impinging on the Schneiderian membrane, produces itching there, followed by a powerful action of the whole respiratory apparatus, established for its removal. The sneezing thus produced is not caused by the transmission of the irritation through the intermediate organs to the respiratory muscles; nor can we explain it by the mechanical or functional connections of organs. It is produced by a mode of correlation: in other words, it is a case of *sympathy*. A small wound in the foot will produce locked-jaw, without our being able to discover or to imagine any greater connection between the foot and the jaw than there is between the foot and other organs of the body. We say that it is caused by sympathy existing between those organs, and, so long as we use the terms to *signify the unknown cause of these connections* it is well. *It must be understood*, however, that we *attach no definite idea to the term*; that it is only employed to express our ignorance of the agent or its mode of action; precisely as we apply the epithet *vital* to a process which we are incapable of explaining by any physical facts or arguments."—*Human Physiology*. By Robley Dunglison, M.D., p. 433. Philadelphia, 1832.

The terms "reflex motory" and "reflex secretory action" more fully explain the *rationale* of phenomena described under the vague term of "sympathy," and which before the time of Marshall Hall were so inexplicable to our ancestors.

cleus which, for the time being, happened to be present. Our object being however that of adjusting the application of these same facts and phenomena, formerly attributed to sympathy, with others of a wider range, to more modern views of nervous physiology, we have here but briefly presented them, only by way of introducing reflex excito-secretory or vaso-motor action, as the true pathogeny of calculous concretions, and as the fundamental condition and real instrumentality by which the calculous diathesis, in whatever type it may appear, is most probably originated. With this view, we have, in the historical and physiological portions of this paper, briefly presented a distinct and concise consideration of the excito-secretory function. We can now therefore proceed to the discussion of our subject without further general remarks.

LITHOGENESIS TO BE STUDIED IN THE NUCLEUS.

As in tracing the history of an obscure word, the philologist must go back to its root; and as in determining the age of some stratum of the earth's crust, the geologist finds it advantageous to study sometimes the minute organic remains imbedded in its mass; so must the lithologist go back to *the nucleus*, to inquire of the origin and to learn the true source of the production of vesical calculus.

In the present portion of our paper we shall review briefly some of the now current and generally accepted theories of the origin and production of calculus as they have been arrived at by customary methods of investigation; and then, by a consideration more particularly of the idiogenic nuclei, endeavor to interpret rightly their significance. The hypothesis which has for the longest time maintained general confidence, is that which attributes the origin, production, and growth of vesical and renal calculi to the calcareous elements held in solution by the drinking-water of the calculous subject. The plausible ground for this wide-spread opinion has been the generally admitted fact that the largest number of calculi have been found to contain as their principal ingredients, some one or more of the salts of lime or of magnesia, the most common and frequent of these earthy salts held in solution by calcareous or what is known properly as "hard-water." And again, it has been further alleged and to a great extent acknowledged, though denied by some, that the largest number of calculi have been produced in

popularity

regions offering *hard-water* as the general beverage of the inhabitants.

These two arguments, as we could show, both from a few of our more striking cases¹ as well as from our references to the experiences of others, more particularly the well-considered conclusions of Prof. Gross,² are theories which cannot be depended on as consistent and satisfactory in accounting for the origin of calculus. For, as has been shown, calculi having alternating strata of lime and magnesia with other ingredients, or solidly composed of lime or magnesia, are often found to prevail abundantly in *free-stone regions* where there are no solutions of these salts in the drinking-water, while, on the other hand, calculous concretions of all kinds are often entirely absent, where lime and magnesian solutions are most abundant. We do not design to give here any extended discussion to this subject as it has been heretofore considered by others, and also in another portion of this paper. It has been seen that we have ever given the most careful attention to *nuclei* as the invariable and necessary *first step* in the order of calculous concretion. Whatever shall be proved in any given calculus or in any number of calculi, to be the constituent of the nucleus, we must be guided by the physical or chemical character of that constituent to the source of the nucleus; and whatever shall be proved to be the most common constituent of all nuclei, will lead us infallibly to the most frequent source and origin of all calculi. Hence the value of the method of tracing the history of the calculus *back to its nucleus*, in order to determine by *its* material the source also of its origination. Studying the history of calculi after this method may lead us to more reliable and sometimes to most unexpected results. By it, in a large majority of calculi—more than five-sixths—we are at once led to exclude lime and magnesia and all other earthy ingredients from the initial stage at least of lithogenesis.

Nearly all idiogenic nuclei can be shown by the abundant testimony of every one who has given intelligent attention to the subject, to be composed of materials into which neither lime nor magnesia enters as an ingredient. In their stead we have, first, and most frequently of all, uric acid; then, successively, cystin, xanthin, plastic mucons and other organic products elimi-

¹ Cases XXXVIII., XXXIX., and XL.

² Urinary Organs.

nated from the blood or mucous membrane of the urinary passages, under some aberration of healthy action or morbid disturbance.

The ^{irritation}~~irritation~~ of calculus then—that is, of the idiogenic or self-originating nucleus—is chemically characterized by an acid constitution of the urine and most probably of the blood, and reasonably is not the *outcome* of such alkalescent ingredients as are supposed to be supplied to the blood and urine by any infusion of the earthy salts taken in the drinking-water of the subject. Taking this strictly chemical view of the conditions known to favor redundancies of uric acid in the blood and in the urine,¹ whatever may be the acknowledged agency of lime and its salts in favoring the rapid and extended growth of the stone *after the entrance of the nucleus into the bladder*, we might almost feel inclined to adopt the opinion of the distinguished medical officer of health for London, Dr. Letheby, and decide that, “because of the lime these hard-waters hold in solution, they *remove acid matters* from the blood and thus act as a grateful medicine to the system,” and—as we add—they therefore rather *prevent* stone than produce it, by neutralizing and decomposing the uric acid in its process of nuclear agglomeration.

We could here particularly dwell upon the phenomena of some two or three of our cases heretofore mentioned, to show that alkaline solutions, whether as medicines or as common drinks, are greatly instrumental in the disintegration and removal of even very considerable uric acid formations.²

Whatever, then, we might suppose would be calculated to lessen or neutralize the superabundance of uric acid in the fluids of the body, and in the urine especially, must lessen, or at least *not favor*, the liability to uric acid nuclei; and in the same proportion as the uric acid nucleus is more frequent than other nuclei will it lessen the liability to calculus. It is well known that the correction of uric acid deposits, amorphous or concrete, has been *by alkalies*, liquor potassæ being most frequently found effectual.

¹ In healthy human urine uric acid seldom exceeds 1 part to the 1000.—Lehman. Almost the only urine in which uric acid is not to be found is in that of the herbivora. In these animals it is found only during the period in which the young is sustained by the milk of the dam. The urine of the calf is abounding in uric acid. The solid urine of serpents is composed almost entirely of uric acid.—Harley.

² See Cases XXXIV., XXXV., XXXVI.

Our own observations, then, of nearly fifty cases of calculus with idiogenic nuclei, as well as our own researches into the recorded experience of others, bear us out in the assertion that, *by an incomparable proportion*, autogenic calculi, both renal and vesical, whatever may be the composition of their external strata, whether continuing throughout as uric acid or composed of one or more of the salts of lime, as phosphate, carbonate, oxalate, or of these salts of lime in combination with magnesia or ammonia or triplicated with both—we repeat, they out of all proportion—have been found to have their idiogenic beginning in some minute agglomeration of *uric acid*. This of course was most reasonably due to aberrated secretory action of the liver (though excreted by the kidneys), or perhaps it may be more acceptably said, of some portion of the digestive apparatus—or in a less frequent proportion—due to some agglomeration of mucus or of other plastic material, the existence of which in the urinary passages, no less than the excess of uric acid, indicates disturbed or aberrated secretory action in the bloodvessels and surfaces of those passages.

HISTORY OF THE IDIOGENIC NUCLEUS.

The origin of the uric acid nucleus, almost invariably found to constitute the initial stage of calculous concretion, becomes in the present investigation an object of much interest. The kidney itself, the spleen and the liver have each been variously charged with supplying to the urine solutions of this ingredient, so often crystallizing into nuclei to form the basis for the precipitation of calculous matter. In a subsequent portion of this paper we have pointed out, in the case of the infant and of the child, the most frequent subjects for the origination of stone, the rationale and also the neuro-dynamic instrumentalities by which the functional derangement necessary to the production of uric acid in the liver and other organs can be brought about. We were intending further to trace to the end the chemical processes by which our all-important object of study, the resultant nucleus, is perfected. This most gladly do we find to be unnecessary; a far more astute thinker and an abler pen has been engaged with this portion of our subject, and most pertinently do we find the *chemistry* already written out to our hand, albeit its relations to infancy and childhood and its neuropathic bearings are nowhere even glanced at. “I need not remind an audience such as that

which I have the honor to address," says Sir Charles Murchison,¹ "that deposits in the urine of lithic acid or lithates are not due to any morbid condition of the kidneys; what I wish to insist upon is, that the frequent occurrence of these deposits in the urine ought always to be regarded as a sign of functional derangement of the liver arising from causes, sometimes temporary, at other times more or less permanent, . . . and that lithuria, like glycosuria, is very often due to functional disease of the liver, although even glycosuria is still ranged in some text-books with albuminuria and diseases of the kidneys." "In other words," he continues, "abnormal disintegration of albuminous matter in the liver may lead to a morbid condition of the blood and of the entire system which often manifests itself in lithuria. This morbid state of the blood I propose to designate lithæmia." The ultimate chemical result as shown by him is, that "the normal process by which albuminous matter becomes disintegrated in the liver into urea is deranged, and it is discharged by the kidneys in the less oxidized form of lithic acid and its salts."

As an unavoidable corollary of his discussion, Murchison decides at once that most urinary calculi have their origin in the excess of uric acid produced by the deranged liver, and even where other products, as cystin, xanthin and oxalate of lime, form the basis of the concretion, he still insists that "the imperfect oxidation and disintegration of albuminous matters in the liver is the common origin of them all." As will be seen hereafter, the functional disturbances in the liver, intestinal canal, and urinary apparatus, resulting from reflected dental irritation, taken in connection with the albuminous food of the infant, present very strong claims as a neuro-dynamic factor in accounting for the preponderance of calculus in the early periods of life.

Having thus traced the history of the idiogenic nucleus from its production in the liver to its agglomeration in the urinary passages, we may now consider the neurodynamic influences which promote the precipitation of calcareous strata upon it, and also upon the xenogenic nucleus, which influences, it is scarcely necessary to state, are the same in either case.

¹ On Functional Derangements of the Liver. Being the Croonian Lectures delivered at the Royal College of Physicians in March, 1874, p. 64.

CALCULOUS PRECIPITATION UPON THE NUCLEUS.

In regard to xenogenic or foreign nuclei, our course of reasoning must be different, the process being more simple and the history long recognized¹ and less obscure. Indeed, the reflex-secretory process set in action *after* the entrance of a uric acid nucleus or of some rarer form of idiogenic nucleus, as cystin, xanthin, mucus, etc., into the bladder, is identical in its subsequent history with that of the minie-ball, the bone-fragment, the bougie, the "needle-case," or that of any other extraneous body which is to form a nucleus. The *dominant centre* of the aberrated secretory process seems now to be changed, together with the excitor surface upon which the irritation is made, and, for this or some other reason, the character of the resultant product too is now almost invariably changed; instead of acid urine, it is now most frequently alkaline, and instead of the crystallizations of uric acid, which very rarely continues, upon the central nucleus, we have the solid product and results of alkaline precipitation in the form of oxalates, carbonates, or phosphates either of lime or of magnesia, or of ammonia in double or triple combinations.

Of course we do not attempt even to define what are these combinations, much less do we undertake—nor do we think we should be asked—to account for their variety or their changes. The scientific and practical chemist is every day surprised at the development of unexpected affinities, and perplexed in endeavoring to account for them: how much more inscrutable must be the affinities in that vital laboratory in which, as yet little understood, neurodynamic influences govern and probably pervert, to a certain extent, the physical laws by which chemical phenomena are ordinarily interpreted.

We would, however, here again gladly call attention to the facts presented by some of our own cases and others that might be quoted in relation with them, to prove that the vast elimination and rapid accumulation of the earthy materials resulting from such reflected irritations did not appear to depend at all

¹ The phenomena of this process, as we have already seen, has long been understood and has been amply accounted for under the doctrines of *sympathy*—which has been fully shown, when translated in the clearer light of modern discovery, to mean *reflex nervous action*. The phenomena were quite familiar and the process of action known, but the instrumentalities had not been clearly recognized, nor their rationale, until the time of Marshall Hall.

upon calcareous matters taken with the food or the drink. One of our patients with the bone-nucleus resided in a region in which slight deposits of lime are here and there found in the soil, though none ever in the water. Another, with the minie-ball nucleus, lived in a region where there is absolutely no lime nor magnesia either in the water or the soil. The bone-nucleus accumulated in four years and one month, one ounce and one drachm of ammonio-magnesian phosphate, while private Griffiss, in about the same time, four years and four months, accumulated on the fragments of lead four ounces and four drachms avoirdupois of what has been decided to be triple phosphates. The other concomitant circumstances between the two patients differed very little in essential particulars.

In the absence of any experiments bearing upon the subject that we have time at this moment to refer to, we will venture to state that from our careful study of our own cases of stone and of those of others as they have occurred in persons affected with diseased lumbar or possibly dorsal spinal centres, or in persons with irritating vesical nuclei centripetally impressing spinal centres; and from the analysis of the urine of partially paraplegic patients, we have formed the opinion that irritations in this region of the spinal cord, whether centric or reflected from the bladder or genital organs, by phymosis, stricture, stone, or enlarged prostate, is nearly always attended by an *alkalescent state of the urine*, and often by amorphous or concrete deposits. Are these phenomena not due to the disturbed or disconcerted action of the spinal centres, or as some would explain it, to the loss of that *inhibitory power* in the centres by which ordinarily the alkalescence and the concretions are prevented?

There is no doubt that in some cases of multiple calculi the continued production of uric acid nuclei, possibly under certain influences to be described hereafter, though a phosphatic elimination is going on, yet on the principle of *alternations* in strata, the issue of new uric acid nuclei is still made at certain periods by the secretory apparatus of the liver and kidney.¹ This combination of diathesis as shown by these nuclei and also by the

¹ Or elsewhere. Dr. Harley seems decided that though the kidney may excrete uric acid it does not form it, and suggests the *spleen*. For our purposes the question is unimportant—reflex vaso-secretory action initiating and continuing the process. According to Murelison, as we have seen, the liver is the unquestionable source of uric acid.

attending strata, it is candidly admitted, has ever been to us difficult of explanation, not only on the basis of our own method of studying this production of stone, but on that of any and of every *other* method. Systematic works on urology explain what they call transitions of diathesis¹ very imperfectly indeed, so far as we can see, by a bare statement of the facts in a circle.

That we have thus far somewhat carefully considered the general influence of the nervous system in modifications of the urinary secretion and its instrumentality in favoring by direct centric influence, as well as by reflex-secretory action, the elimination of both nuclear and calculous materials from the blood, and thus favoring the formation of deposits in the urinary passages—is, we think, quite apparent. In the large class of cases which we have now to investigate, the study of reflex excito-secretory, or vaso-motor action, as an instrumentality in the origination of calculus, can be pursued under conditions and after a method not clearly applicable to the foregoing cases, which cases, however, it will serve, as we think, very greatly to elucidate.

REFLEX EXCITO-SECRETORY ACTION, AS OPERATIVE DURING THE FIRST AND SECOND DENTITION OF INFANCY AND CHILDHOOD, THE TRUE CAUSE OF THE PREVALENCE OF CALCULUS DURING THOSE PERIODS.

Of all the applications that can be made of the excito-secretory function in the elucidation of disease, the study of its profound influence as connected with lithogenesis in infancy and childhood is the one most hopeful and inviting still left to the pathologist.

In the reported experience of the large majority of surgeons the number of children and of young persons, under fifteen years of age, operated on for stone is quite remarkable. On an average, we have no doubt, much more than half the cases would come under the above-named period of life. In one of his lists Dr. Gross mentions that "over one-half were children." It will be seen that this is the proportion in our own operations. Dr. Dudley's cases were three-fourths children, while the largest proportion of children given we believe by any author, is that of Dr. De Roos, of St. Petersburg, Russia. Of four hundred and sixty-nine cases operated on at St. Mary's Hospital at Moscow, *all were children* except seventy-seven.²

¹ Prout, p. 79.

² By Dr. Gross, from Gazette Médicale de Paris, Dec. 2, 1838.

"In attempting to form a correct estimate of the relative frequency," says Dr. Gross,¹ "of calculous complaints in children, adults, and old persons, we must not lose sight of the fact that many of the cases which fall into the hands of the surgeon are examples of long standing, extending perhaps through a period of many years. It often happens that a youth of fifteen is cut for a stone developed in infancy, and a person of twenty-five may have carried a calculus since ten." Though the above very large proportion of children, as compared with adults affected with calculus, can be shown, it is somewhat remarkable, and as we hope to show *significant*, that so very small a proportion of these are found to occur *before the age of twelve months*. "It is a singular fact," continues Dr. Gross, "that of *six thousand and forty-two* cases not more than three occurred before the end of the first year. By far the largest number occurred within the first ten years." So remarkable an exhibition of the prevalence of a particular period of life in an affection not heretofore regarded by any means as especially an infantile disease, should certainly at once arrest our attention, and having done so, it cannot fail to evoke diligent investigation as to the causes determining so large a majority of subjects of this particular age to that affection. We are not aware that any inquiry into this relation of our subject has ever as yet been made.

Were we, on the recognition of the bare coincidence of this period of *greatest prevalence of calculus* with the highest activity of that important physiological but highly irritative process of infantile life known as the *process of dentition*, to state that an etiological relation of the most influential character subsisted between the two events, we might very properly be answered, that mere simultaneousness of occurrence is by no means a sufficient ground to establish *causal relations* of such grave and significant importance. Let us therefore present as briefly as possible some rational grounds as the foundation for such an opinion.

THE RATIONALE OF THE FIRST AND SECOND DENTITION IN THE CALCULOUS FORMATIONS OF CHILDREN.

The process of evolution which is involved in the full development of the early teeth and of that portion of the upper and lower jaws intended for their firm and permanent accommoda-

¹ "Urinary Organs."

tion, that they may answer the exigencies of after life—though interrupted by a time in which perhaps no active changes are obvious—is admitted by most observers to occupy more or less completely a period of over seven years. During two stages of this time, from about the 8th to the 30th month, and less markedly from the sixth to the end of the seventh year, an active process of growth and development is in process. In the first dentition, especially the attendant local irritation and general excitability of the child's nervous system are too obvious to require scarcely a remark. The gums are swollen and tender, the buccal membrane often hot and dry, or the salivary secretion may be excessive. There is a disposition to relieve the local irritation by pressure on the gums, there is general restlessness and excitability, which, it is well known, often, by reflex motory transmission through the spinal centres to the muscles, become exaggerated into violent and dangerous convulsions.

Besides these manifestations of reflex excitability in the cerebro-spinal system, it has also been shown that reflex agencies are at work to modify the vaso secretory innervation of almost the entire body. The most marked derangements have been shown to exist in the chylipoetic viscera, the liver, especially the stomach and the intestinal canal, manifest the most obvious derangements, and diarrhœa and cholera infantum have for their synonyme the word "teething" to express them. As we have just said the kidneys and bladder do not escape, but also become deeply involved in the general exaggeration of reflex vaso-secretory action propagated through the spinal centres by dental irritation.

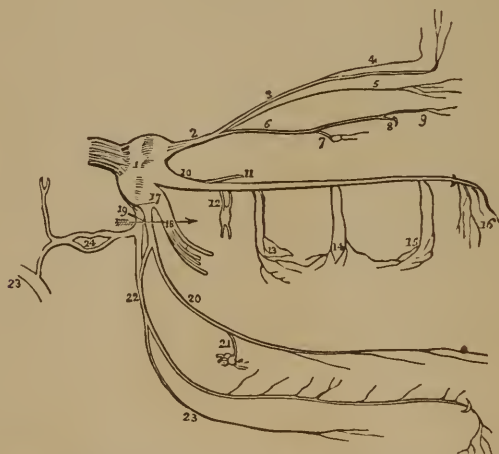
The phenomena of the second dentition, though of a less marked and distressing character, we hope to show hereafter are indicative of important results in other portions of the system.

Having occasion to investigate, as early as 1850,¹ the reflex secretory relations of dentition to cholera infantum, our attention was at that time particularly called to the frequent occurrence of the marked disturbances in the action of the urinary organs in children passing through the process of dentition; profuse diuresis, sometimes dysuria, occasionally hæmaturia, and nearly always at some period great vesical irritability with tenesmus and the passing of vesical mucus, were some of the

¹ An Essay on The Influence of Dentition in Producing Disease.—*Southern Med. and Surg. Journal*, June, 1850.

manifestations of such disturbance observed by us as not unusual concomitants of this process. Referring to writers upon the subject we found that Hunter,¹ Underwood,² Laycock, and Bingham, had made reference to the phenomena, each corroborating our observations of these phenomena attendant upon the teething process so far as the bladder and kidney were concerned; "The growth of the teeth," says Dr. Laycock,³ "is accompanied by an increased flow of urine, by symptoms of gonorrhœa and of stone in the bladder, and by involuntary micturition." No attempt, however, was made by any of these authors to describe the avenues and connections through which the transmission of dental irritation could be propagated to the kidneys and bladder, the organs affected by the vascular and secretory disturbance. These we have distinctly defined to be: 1st. The dental branches of the fifth pair, or trifacial nerves; 2d. The medulla oblongata

Fig. 6.



THE BRANCHES OF THE FIFTH NERVE.—1. The Gasserian ganglion. 2. The ophthalmic nerve. 3. The frontal nerve. 4. Its supra-trochlear branch. 5. The lachrymal nerve. 6. The nasal nerve. 7. Its branch of communication with the ciliary ganglion. 8. The passage of the nerve through the anterior ethmoidal foramen. 9. The infra-trochlear nerve. 10. The superior maxillary nerve. 11. Its orbital branch. 12. The branches of communication with Meckel's ganglion. 13. The posterior dental branches. 14. Middle dental branches. 15. The anterior dental branches. 16. The infra-orbital branches. 17. The inferior maxillary nerve. 18. Its external or muscular division. 19. The internal division of the inferior maxillary nerve. The arrow marks the separation of these two divisions of the nerve by the external pterygoid muscle. 20. The gustatory nerve. 21. The branch of communication with the submaxillary ganglion. 22. The inferior dental nerve, arising by two roots. 23. Its mylo-hyoidean branch. 24. The auricular nerve. 25. Its branch of communication with the facial nerve.

¹ The Natural History of the Human Teeth, p. 234.

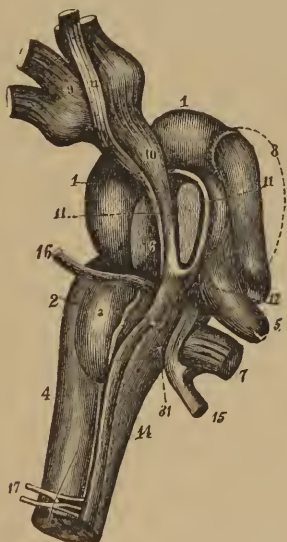
² On Diseases of Children. Ninth edition, edited by Marshall Hall, p. 252.

³ Essay on Hysteria, p. 86. American edition. Philadelphia, 1840.

where it receives the central extremity of the sensory division of this nerve, under the floor of the fourth ventricle; and lastly, the ganglia, their roots and branches of distribution, through the vesical and renal plexuses of the sympathetic, to the vessels and secretory glands and surfaces of the liver, kidneys, and bladder.

In order to present clearly to the reader every portion of the nervous apparatus utilized as the instrumentalities of the reflex vaso-secretory process, which we claim is the direct agency through which the liver principally, and perhaps other digestive organs in the first and second dentition, are excited to furnish materials for the temporary lithic or uric acid diathesis—so abundantly productive of idiogenic nuclei and therefore of the calculi of this early period of life—we here introduce from a systematic work¹ a representation of the sensory portion of the trifacial with its upper and lower dental branches, together with the references (Fig. 6). The foregoing outline exhibits almost

Fig. 7.



LATERAL VIEW OF THE PONS, SPINAL BULB, AND COURSE OF THE FIFTH NERVE IN MAN.—1. Pons Varolii. 2. Spinal bulb. 3. Olivary body. 4. Spinal cord. 5. Superior peduncle of cerebellum. 6. Cut surfaces of middle cerebellum. 7. Inferior peduncle of cerebellum. 8. Cut surface of crus cerebri. 9. Ganglion of fifth nerve reversed. 10. Ganglionic portion of the nerve. 11. Non-ganglionic portion of fifth nerve. 11'. Roots of non-ganglionic portion. 12. Eminence at the insertion of both portions of the fifth nerve. 13. Fasciculus to anterior column of spinal cord. 14. Fasciculus to posterior column. 15. Auditory nerve. 16. Portio dura. 17. Posterior roots of superior cervical nerves.

¹ Wilson's Dissector, p. 177

the entire receptive and centripetal portions of the apparatus concerned in this process. The dental filaments in both the upper and lower jaw, emanating from the structures surrounding, and concerned in, the active capillary and vaso-trophic processes subsidiary to the development of the young teeth, join directly the main trunk of each maxillary nerve, the fibres of each of which, passing through the Gasserian ganglion, unite to form the combined trunk represented as abruptly truncated on the left of this body.

The continuation of the trunk of the sensory portion of the trifacial into the posterior columns of the medulla, *which form the floor of the fourth ventricle*, is fully illustrated by Fig. 7, from Todd, representing "the central connections of the fifth pair."

By this direct implantation¹ the sensory trunk of the trifacial is brought into intimate excitator relations with the three several elements of the cord—so clearly differentiated and distinctly appropriated by Jacobowitsch to motion, sensation, and secretion—thus adapting it, by its actual physical connections with each class of these cells, to become the reflex excitator to any one of these classes of cells or to all of them combined. The mere anatomical and mechanical connection of the sensory fibres of the fifth pair to the medulla oblongata, the admitted teleological relations of the several kinds of cells composing its elements, and the various efferent nervous distributions issuing from its ganglia, all intimately related, as we have said, with efferent fibres of this sensory portion, would indicate plainly the widespread influence it is capable of exercising even had no experimental demonstration been made to give unquestionable verification to the fact. This last convincing evidence has, however, been most satisfactorily and abundantly supplied.

¹ It is scarcely necessary to remark upon this origin here given of the sensory portion of the trigeminus. It is that traced by Dr. Alcock, of Dublin, and given in *The Cyclopædia of Anatomy and Physiology* as the result of his dissections, and it confirms the statement of Sæmmering, that it appears to arise *almost from the very floor of the fourth ventricle*. Erasmus Wilson adopts it, and Herbert Mayo has verified it. Dr. R. B. Todd says (*Physiological Anatomy of Brain and Cord*): "The ordinary columns are seen distinctly in their ascent to the brain *in the floor of the fourth ventricle*, as two cylinders [see our Fig. 8, A and F] *which form the floor of the fourth ventricle*." It is, perhaps, more properly stated by Alcock, as being *beneath* the floor of the fourth ventricle. We are thus particular, as the exact relation of its origin to the centric nervous matter has a bearing upon the identity of its behavior, under dental irritation, with the experimental results obtained by Claude Bernard.

Some time in 1852 M. Claude Bernard, of Paris, performed certain experiments to determine the influence of the galvanization of certain nerves upon the secretory functions of various organs. Having abandoned these, he next instituted others, which more recently we find clearly and satisfactorily illustrated in his lectures delivered at the College of France during the sessions of 1854 and 1855, and published in Paris, 1855 and 1856.¹ These brilliant experiments, as we have before said, have won for M. Bernard a well-earned and enduring fame and have done much towards the advancement of physiological science. Begun two years after the publication of our views in regard to the reflex excito-secretory influence of dentition through the fifth nerve on the secretions of the liver, intestines, kidney, and other organs, and not published till fully five years after, they yet afford the most singularly accurate demonstration and verification of their truth in every particular.² These experiments consisted in mechanical irritations, applied by means of delicate, pointed instruments, to the nerve-centres and cords in the fourth ventricle at the point, as will be seen, of implantation of the sensory trunk of the fifth nerve. The following description shows how exactly the experimental results, as obtained in the case of animals, correspond with the results attributed some years before to the same source, from the observation of the effect of

¹ Leçons de Physiologie Experimentale, etc.

² The following are our own contributions on Reflex Secretory Action:—

1st. "The Influence of Dentition in Producing Disease." Read before the Medical Society of Augusta, May 2d, 1850.—*Southern Medical and Surgical Journal*, June, 1850.

2d. "The Sympathetic Nerve in Reflex Phenomena—A Question of Priority of Announcement with M. Claude Bernard."—*Transactions of the American Medical Association*, May 5th, 1852, Vol. VI., p. 49.

3d. "A Claim of Priority in the Discovery and Naming of the Excito-Secretory System of Nerves—A Letter to Dr. Marshall Hall, of London," March 2d, 1857.—*Southern Medical and Surgical Journal*, March, 1857, and *London Lancet*, May 2d, 1857.

4th. "The Excito-Secretory System of Nerves. Its Relations to Physiology and Pathology."—Prize Essay of the American Medical Association.—*Transactions*, Vol. X., May, 1857.

5th. "Meckel's Ganglion."—*Southern Med. and Surg. Journal*, Feb. 1858.

6th. "Classification of Febrile Diseases by the Nervous System."—*Transactions of the Amer. Med. Association*, Vol. X., 1857.

7th. "The Nervous System in Febrile Diseases and the Classification of Fevers by the Nervous System."—*Transactions of the Amer. Med. Association*, Vol. XI., p. 551, May, 1858.

morbid irritation in the same organs of the child under the influence of dentition.

"We find," says a cotemporary writer,¹ "minute details regarding the mode in which Bernard performs his celebrated experiment of inducing *artificial diabetes* by pricking a certain point of the *medulla oblongata* either of an herbivorous or a carnivorous animal; but until we read these lectures we were not aware that he had extended his experiment in the manner described in the following paragraph: "When we prick the mesial line of the floor of the fourth ventricle in the exact centre of the space between the origins of the auditory and pneumogastric nerves, we at the same time produce an exaggeration of the hepatic (saccharine) and *renal secretions*; if the puncture be effected a little higher we very often only produce an augmentation in the *quantity* of the urine, when this frequently becomes charged with albuminous matters; while if the puncture be

Fig. 8.



POSTERIOR VIEW OF THE MEDULLA OBLONGATA, WITH MESOCEPHALE AND PART OF CEREBELLUM OF AN INFANT.—S. Pineal gland D. Nates. D'. Testes. ++. Points of emergence of fourth pair of nerves. Y. Posterior pyramids. X. Restiform columns. A, F. Floor of the fourth ventricle, formed by the olivary columns, the fissure between which is the calamus scriptorius. Y'. Posterior surface of mesocephale. B. Valve of Vieussens. N. Anterior surface of crus cerebri. R. Corpus dentatum or rhomboideum.

¹ British and Foreign Medico-Chirurgical Review, January, 1857, p. 32.

below the indicated point, the discharge of sugar alone is observed, and the urine remains *turbid* and scanty." Fig. 8, from Foville, exhibits the floor of the fourth ventricle.

It will be seen by examination of Fig. 9, from Bernard, that the

Fig. 9.



SECTION OF A RABBIT'S HEAD TO SHOW THE DIRECTION OF THE PERFORATION. *a.* Cerebellum. *b.* Origin of the seventh pair of nerves. *c.* Spinal marrow. *d.* Origin of the pneumogastric nerve. *e.* Orifice by which the instrument enters the cranium. *f.* Instrument. *g.* Fifth pair of nerves. *h.* Auditory canal. *i.* Extremity of the instrument reaching the medulla after traversing the cerebellum. *k.* Occipital venous sinus. *l.* Tubercula quadrigemina. *m.* Cerebrum. *n.* Section of the atlas.

place indicated for introducing the point *i* of the piercing instrument *f*, in order to increase the secretion of urine and to change its character, is very near the implantation of the root of the fifth pair of nerves, *g*. Hence we may say that this operation illustrates, as perfectly as any artificial measure possibly can, in the irritation produced and the results obtained, the more gradual and permanent effect of this persistent and long-continued dental irritation constantly transmitted during months of vasotrophic excitement, from the peripheral dental filaments through the trigeminal trunk to the floor of the fourth ventricle. This irritation is thence reflected, under the special influence of the ganglionar cells of Jacobowitsch most probably, directly by avenues histologically and functionally congenial, viz., the secretory ganglia and trunk of the splanchnic and finally the distributed branches of the sympathetic, in the coats of the bloodvessels and

among the capillaries—the “vaso-motor nerves”—well named and described by Dr. Brown-Séguard, and “concerning which,” in the language of Dr. Austin Flint, Jr., “so much has been written within the past few years.”

Fig. 19.



Cerebro-spinal and Splanchnic Nervous Systems of a Rabbit, showing the nervous connections existing between the liver, lung, and kidney, to explain the production of artificial diabetes, and by the same rationale, the neuro-dynamic production of uric acid for infantile nuclei.

To show at one glance these latter avenues for the transmission of reflex vaso-secretory irritation, whether experimentally produced on the nerve-centre at the floor of the fourth ventricle or by a less direct process, viz., the vaso-trophic irritation—long protracted, often varying, and perhaps sometimes gradually increasing—established at the distant peripheral ends of the dental branches of the centripetal trigeminus by the development of teeth, either in the first or in the second dentition, we present the following excellent dissection (Fig. 10) from the published lectures of M. Claude Bernard.

By a careful inspection of the above delineation it will be apparent that all the nervous instrumentalities, down to the minutest distribution of ultimate filaments to the vascular structures of the secretory organs, are accurately adjusted to carry out the last step in the modification of the hepatic and urinary secretion, both as to their quantity and elements. Whether with those who believe that the superinduced excess of uric acid is formed in the kidney or, with Harley, in the spleen, or, as is most probable, with Murchison, in the liver, the appropriate plexuses accompanying the larger vessels of each of these organs are here seen to supply the filaments for the transmission of the distant dental irritation which initiated, as the first step, the vaso-secretory action underlying and originating the lithogenic process; hence the idiogenic nucleus upon which precipitation is to gather in the formation of calculi.

In connection with the consideration of infantile and puerile production of stone under trigeminal irritation of first and second dentition, we will here remark upon one of our cases, which we think may be recognized as possessing some degree of relative significance. It is Case XLIV., that of Margaret Robinson, aged about seventeen years, affected from an early period with an irritating disease of the cheek, jaw, and mouth, locally causing the continued flow of saliva and greatly impairing her general health. It will be seen that this young woman was the subject of a large alternating calculus weighing one ounce. It was almost spontaneously expelled in the last moments of exhaustion. In view of the great infrequency of calculus in the female, the fact that one of the four cases occurring to us in the course of thirty years was one in which a persistent and long-continued irritation of the buccal sensory nerves was present, somewhat assimilated it etiologically to the dentition cases of

infancy and childhood, heretofore considered, as arising from reflected dental irritation. To us it appears both pertinent and significant when viewed in the light of the physiological and pathological investigations in which we have been engaged.

SUMMARY.

Having thus carefully presented the anatomical and physiological relations of this portion of our subject, we may summarize a few facts, some of which appear to exclude the hard-water theory of lithogenesis, while they strongly corroborate that of the neuro-dynamic origin of calculus.

First. The largest proportion of subjects being infants at nursery periods of life, the calcareous solutions are not taken by them to furnish the lime for calculous concretions, while the adult, who rarely originates stone, drinks freely of them.

Secondly. As heretofore shown, uric acid forming the nucleus of nearly all calculi, so far from being favored by solutions of lime, would rather be dissolved by them.

Thirdly. The food of the nursing infant being largely albuminous—as in the case of the sucking herbivora, uric acid is found to predominate in the blood and urine. This uric acid, which in the adult exists in less proportion and is probably dissolved in hard-water districts, in the infant forms a nucleus without the chance of solution in the absence of alkaline drinks.

Fourthly. The albuminous food of infancy furnishing abundant material out of which uric acid may be produced, the one overshadowing influence instrumental in its production and in the formation of idiogenic nuclei is the functional disturbance of the liver—*hepatic paresis*—which during this period is produced by reflected dental irritation as heretofore demonstrated. As glycogenesis is artificially produced in the experimental demonstration of Claude Bernard by irritating the floor of the fourth ventricle, so lithogenesis in the nursing infant is morbidly produced by reflected dental irritation of the fifth pair implanted in the same nerve-centre. Imperfect disintegration and imperfect oxidation of albuminous material in the liver is the result of the hepatic paresis thus superinduced. Hence, idiogenic nuclei and, consequently, calculi, are abundant at this period.

Fifthly. After nuclear agglomeration *has taken place*, another excitator of reflex irritation, and new avenues of transmission, are established. The idiogenic nucleus and the xenogenic, from this

time, have a common history; both excite, in a like degree and in the same manner, the elimination from the blood and precipitation of the calcareous elements in the further development and growth of the stone. Calcareous solutions, as drinking-water, probably, now add considerably to the rapidity of accretion.

Sixthly. Although we regard dental irritation, as heretofore described, to be the chief originator of the uric acid nucleus and therefore of the vast majority of autogenic calculi, we cannot exclude the recognition of other influences as giving rise to calculi both in the infant and adult; as all xenogenic nuclei are known to originate calculi and to become covered with calcareous—not often uric acid—strata, by a process of reflex irritation, beginning in the bladder. Irritations of the urethra, of the prostate gland, of the prepuce, all, as we have shown, originate nuclei and promote precipitation; under the influence of spinal injury, we have seen immense productions of calcareous deposits continued in one case—O'Bannon's—for over thirty-nine years.

Seventhly. The influence of living in malarial districts may well and rationally be accepted as acting most potently in the neuro-dynamic origination of calculus. Whether in hard-water districts or in free-stone regions it is known that the nervous system sustains serious impairment of its controlling functions over the secretory organs¹ through malarial blood-intoxication. No organ suffers greater functional derangement than the liver, and on rational grounds we may predicate the abundant production of uric acid and the nuclear agglomeration of idiogenic nuclei. The “critical discharge” of every paroxysm is but the throwing down of earthy phosphates, the *ashes* of the burnt up

¹ It has been observed by M. Burdel, of Viernon, in a paper addressed to the French Academy of Sciences, that malarial fevers seriously disturb the glyco-genic functions of the liver. These are his conclusions: 1st. In paludal fevers there exists a true diabetes or glucosuria. 2d. This glucosuria is only ephemeral, being the indication of derangement of the organism. It appears with the fever, persists during its continuance, and disappears with it. 3d. Glucosuria in paludal fever shows clearly the existence of a special agency destroying the equilibrium existing between the cerebro-spinal and sympathetic systems. 4th. This explanation of Claude Bernard is confirmed by the following facts: The more violent the access, the more intense the chill, the larger also the quantity of sugar in the urine; on the contrary, when the attacks have been frequent and have lost their force, and in a word the more cachexy is established, the less sugar is produced.—*Union Médicale*, 1859, No. 139.

tissues of the body.¹ Thus, under nervous aberration in malarial fever too, we have the production of the uric acid nucleus and also the limy phosphates for super-stratification.

It will thus be seen that, even when we leave the immense catalogue of cases in which the genesis of uric acid nuclei can be clearly traced to reflex dental irritation, we still find greater consistency in the neuro-dynamic etiology than in any other mode of tracing their origin. The subject, in the particular relations in which it has occurred to us, is indeed a vast one, and the field we have entered is one in its present bearings of almost unbroken ground. Some may be discouraged at the labor involved in pursuing a line of thought through the labyrinth of intertangled dependencies necessary to our conclusions; but we are confident that the present method takes us at least in the right direction, and that the study of neuro-dynamic influences, among other obscure questions, will every day become more and more an object of careful attention. We earnestly and confidently hope the important problem of the several calculous diatheses will find full and early solution.

¹ Report on the Nervous System in Febrile Diseases and the Classification of Fevers by the Nervous System. Transactions American Medical Association, vol. XI., p. 549, 1858.

